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FOREWORD

This Manual was prepared by the Structural Research and Development Group, Structures Section, Research and Development Division of Republic Aviation Corporation. The work was initiated under Contract AF33(616)-6066 in the 750A Applied Research Program, the Mechanics of Flight, Project No. 1367, Structural Design Criteria, and Task No. 14002, "Structural Analysis Methods". The work is now documented under Task 136710. This work was initiated under the direction of the Structural Analysis Unit, Structures Branch, Aircraft Laboratory, Directorate of Laboratories, Wright Air Development Center.* Mr. I. Winnegrad acted initially as project engineer and was succeeded by Mr. C. Richard. The Manual was completed under the direction of the Structural Analysis Unit, Configuration Research Section, Structures Branch, Flight Dynamics Laboratory, Deputy Commander/Technology, Aeronautical Systems Division, with Mr. G. E. Maddux as Project Engineer.

The work was coordinated and supervised by Dr. R. S. Levy, Head of the Structural Research and Development Group. His valuable suggestions and criticisms are gratefully acknowledged as are those of the following personnel of the Applied Research and Development Division of Republic Aviation Corporation: Mr. A. Alberi, Acting Manager of Technical Engineering; Mr. C. Rosenkranz, Acting Chief Structures Engineer; and Mr. C. Meissner, Principal Structures Engineer.

NOTES ON USING THE MANUAL

This Manual consists of five basic sections, divided into numbered sub-sections and paragraphs. For simplicity in cross-referencing material in the text, all portions of the Manual designated with a two-tier number (e.g., 1.1) are considered sub-sections, and all portions designated by numbers of three or more tiers (e.g., 1.1.1 or 1.1.1.1) are considered paragraphs.

Throughout the Manual, the numbered paragraphs (or sub-sections) have been used as the basis for numbering figures, tables, and equations, with new sequences beginning with each numbered paragraph. Figure and table numbers consist of an appropriate paragraph number, followed by a sequence number for the particular figure or table. For convenience the paragraph designations have been omitted from the equation numbers. When an equation from another paragraph is cited in the text, the number of the paragraph in which that equation occurs is also cited. When a paragraph number is not given in conjunction with the citation of an equation, it is to be assumed that the equation is included in the paragraph in which the citation occurs.

References are listed at the end of those sections which have more than one reference. In addition, each section contains its own complete table of contents and list of symbols.

*Now under direction of Flight Dynamics Laboratory, Directorate of Aeromechanics, Aeronautical Systems Division.

ABSTRACT

This second volume of the Thermo-Structural Analysis Manual considers additional problems in the field of thermal and mechanical stress analysis not fully treated in Volume I. Special emphasis is given to nonlinear analysis of beams and plates and to axisymmetric thermo-elastic analysis of thin shells. Following the format of Volume I, nondimensional graphs, formulas and tables are developed where feasible. For clarification of the analytical techniques and the use of the numerical data, illustrative examples are given.

The following problems are treated in five individual sections:

(1) Large deflection analysis of straight elastic beams with axial end restraint and axial end loads coupled with transverse loading and temperature,

(2) Approximate determination of the axial end loads and deformations in heated beam columns with initial eccentricities,

(3) Approximate solutions for the buckling of eccentric columns accommodating nonlinear stress-strain laws,

(4) Axisymmetric large deflections of circular plates subjected to thermal and mechanical loads,

(5) Axisymmetric thermo-elastic analysis of thin shells.

PUBLICATION REVIEW

This publication has been reviewed and is approved.

FOR THE COMMANDER:

R. F. Hoener

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Chief, Structures Branch
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INTRODUCTION

This Volume II of the Manual is an extension of the basic work presented in Volume I and covers the following special problem areas in heated beams, plates and shells:

(1) Nonlinear beam analyses including the effects of initial eccentricities and nonlinear material properties.

(2) Elastic circular plates loaded and heated axisymmetrically, considering the effects of large deflections

(3) The axisymmetric thermoelastic analysis of shells developed in Volume I is generalized, removing the restrictions on geometry and including the effects of arbitrary temperature variations through the thickness.

The material is presented in the form of five independent reports or sections.

The emphasis has been placed on the development of analytical techniques and formulas with their corresponding physical interpretations. Where feasible, the investigations are self-contained, starting with fundamental theoretical considerations and notions in the field of static thermo-structural analysis. However, the reader may find it useful to refer to Volume I where a systematic development of the basic concepts is given.

Brief summaries of the five sections of this volume of the Manual follow.

Section 1. Beam Columns Subjected to Elevated Temperature and Mechanical Loads

This section treats beam columns with axial end restraint and end loads coupled with transverse loads and temperature gradients. Numerical results, "exact" within the framework of large deflection beam theory are tabulated for certain cases.

Section 2. Approximate Solution for an Axially Restrained Column Subjected to Elevated Temperature and Lateral Load

This section presents an approximate method of solution of the heated beam column problem. The method is amenable to problems involving spanwise variations of load thermal gradients and stiffness and permits treatment of initial eccentricities.

Section 3. Approximate Solution for the Buckling of Eccentric Columns

This section develops and presents nondimensional curves to predict column buckling loads. Nonlinear stress-strain relationships are accommodated as well as lateral loads and initial eccentricities or thermally induced deformations.

Section 4. Axisymmetric Large Deflections of Circular Plates Subjected to Thermal and Mechanical Loads

The interaction of membrane stresses and bending is considered for axially restrained circular plates subjected to heat and load. The differential equations governing the axisymmetric case are derived and an iterative digital scheme is used to obtain numerical results for a special case over a wide range of temperature and load parameters.

Section 5. Axisymmetric Stresses and Deflections in Shells Due to Thermal and Mechanical Loads

The general equation for linear elastic analysis of axisymmetric shell problems is developed including the effects of temperature and load. The special cases of conical and cylindrical shells are developed and a numerical example is given for a cylinder with temperature gradients through the thickness and along the length.

SECTION 1

BEAM COLUMNS SUBJECTED TO ELEVATED TEMPERATURE AND MECHANICAL LOADS

by

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SECTION 1

BEAM COLUMNS SUBJECTED TO ELEVATED TEMPERATURE AND MECHANICAL LOADS

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SECTION 1

BEAM COLUMNS SUBJECTED TO ELEVATED TEMPERATURE AND MECHANICAL LOADS

1.1. SUMMARY

This report considers the nonlinear analysis (large deflections) of beams with axial end restraints and axial end loads coupled with transverse loading and temperature.

In order to keep the number of parameters within practical limits the following conditions are investigated:

(1) Distributed transverse loads are uniform over the span while concentrated loads are at the midspan.

(2) The temperature varies linearly through the depth and is constant in a spanwise direction.

(3) The beam is assumed to be simply supported at its ends for bending and elastically restrained axially (Figure 1.3-1).

Tables of numerical results in nondimensional form are presented for the cases of zero and full axial end restraint in rectangular beams. These tables may be used to determine maximum deflections and bending moments.

1.2 INTRODUCTION

In structural analysis beam columns differ from simple beams in that the addition of axial end loads and restraints interact with transverse loads in a nonlinear manner, thus invalidating the principle of superposition (Reference 1-1).

When the axial end loads are specified and the beam is unrestrained axially, the solution for bending moments and deflections are obtained, in general, by solving a linear, nonhomogeneous differential equation with constant coefficients subject to appropriate boundary conditions. If, in addition, the beam is restrained axially, the total end load is an unknown and an additional compatibility relation must be employed.

The analysis presented considers a beam of constant cross section for which the Bernoulli-Euler assumption of classical beam theory is employed. This implies that plane sections perpendicular to the centroidal axis before bending remain plane and perpendicular to the deflected centroidal axis. It is further assumed that the material behavior is linearly elastic.

It can be shown that the seemingly approximate technique used below (Sub-section 1.3) yields results which are identical to those obtained by a moderately large deflection analysis in which nonlinear strain-displacement relations are employed.

1.2 (Cont'd)

The following symbols are used throughout this section:

b	Width of rectangular beam
h	Depth of beam
x	Spanwise coordinate
y	Vertical deflection
$\bar{y}$	Nondimensional central deflection
A	Cross sectional area
E	Young's modulus
H	Magnitude of axial load in beam
I	Moment of inertia
2K	Spring stiffness of axial end restraint
L	Half beam length
M	Bending moment
$\overline{M}$	Nondimensional central bending moment
P	Known applied axial end load
2Q	Concentrated midspan transverse load
$\widetilde{Q}, \overline{Q}$	Nondimensional concentrated midspan load
T_i, T_o	Temperatures at lower and upper beam faces, respectively
$T_d, \overline{T}_d$	Nondimensional temperature differences between upper and lower beam faces
$\overline{T}$	Nondimensional average temperature
W	Intensity of uniformly distributed transverse load
$\widetilde{W}, \overline{W}$	Nondimensional uniformly distributed load
α	Coefficient of linear thermal expansion
β	Ratio of distance from lower beam face to centroidal axis to the total depth
λ	$\pm\sqrt{\frac{H}{EI}}$
$\bar{\lambda}$	λL, nondimensional
σ	stress

SUBSCRIPTS

M	Due to mechanical loads
T	Due to temperature

1.3 DERIVATION OF BASIC EQUATIONS

The beam (Figure 1.3-1) is referred to a rectangular coordinate system in which transverse deflections y and distances along the centroidal axis are measured from a point on the undeflected centroidal axis at mid-span. Specified axial end loads are denoted by P and the elastic axial restraints are shown schematically as springs with stiffness 2K. We assume uniform distributed loads of intensity W and a mid-span concentrated load of magnitude 2Q. The temperature variation through the thickness is linear, varying from T_i at the lower extreme fiber to T_o at the upper extreme fiber.

Since the temperature distribution varies linearly with respect to Cartesian coordinates it produces no stresses in an externally unrestrained beam (Reference 1-2). In this case, the stress-free thermal curvature is given by

$$y''_T = \frac{\alpha(T_o - T_i)}{h} \quad . \tag{1}$$

1.3 (Cont'd)

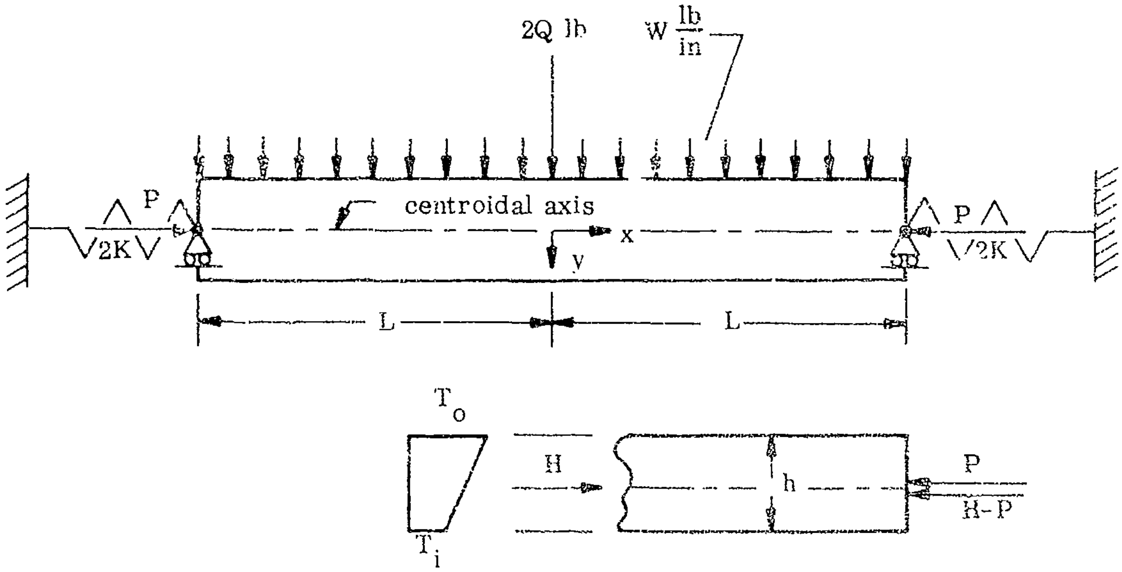

FIGURE 1.3-1 BEAM COLUMN - MODEL USED FOR ANALYSIS

We now consider that the external specified and redundant mechanical loads are applied to this thermally bent beam. Designating the additional curvatures produced by these mechanical loads as y''_M, it follows that

$$y''_M = \frac{-M}{EI} = \frac{1}{EI}\left[\pm Hy - (WL + Q)(L - x) + \frac{W}{2}(L - x)^2\right] , \tag{2}$$

where positive moments cause compression in the outer fibers, y is the total deflection, and H is the magnitude of the axial load in beam*. The negative and positive signs in the first term of the right hand side of Eq. (2) refer to compression and tension respectively. Adding Eqs. (1) and (2) and rearranging yields

$$y'' \pm \frac{Hy}{EI} = \frac{W}{2EI}(L - x)^2 - \frac{(WL + Q)(L - x)}{EI} + \frac{\alpha}{h}(T_o - T_i) . \tag{3}$$

Due to symmetry it is only necessary to consider one half of the beam, so that the differential equation given by Eq. (3) applies in the interval $0 \le x \le L$ and y(x) is an even function, i.e., y(x) = y(-x). The boundary conditions are given by

$$y'(0) = y(L) = 0 . \tag{4}$$

1.4 SOLUTION OF EQUATIONS

The complete solutions of Eqs. (3) and (4) of Sub-section 1.3 for the cases of axial compression and tension, respectively, are written as follows.

---

* H is always taken as positive, regardless of whether the axial load is tensile or compressive.

1.4 (Cont'd)

(1) Axial Compression

$$y = \frac{Q}{EI\lambda^3}\,\frac{\sin\lambda(L-x)}{\cos\lambda L} + \frac{\cos\lambda x}{\lambda^2\cos\lambda L}\left[\frac{W}{EI\lambda^2} - \frac{\alpha}{h}(T_o - T_i)\right]$$

$$+ \frac{Wx^2}{2EI\lambda^2} + \frac{Qx}{EI\lambda^2} + \frac{1}{\lambda^2}\left[\frac{\alpha}{h}(T_o - T_i) - \frac{QL}{EI} - \frac{WL^2}{2EI} - \frac{W}{EI\lambda^2}\right] . \qquad (1a)$$

(2) Axial Tension

$$y = \frac{Q}{EI\lambda^3}\,\frac{\sinh\lambda(x-L)}{\cosh\lambda L} + \frac{\cosh\lambda x}{\lambda^2\cosh\lambda L}\left[\frac{W}{EI\lambda^2} + \frac{\alpha}{h}(T_o - T_i)\right]$$

$$- \frac{Wx^2}{2EI\lambda^2} - \frac{Qx}{EI\lambda^2} - \frac{1}{\lambda^2}\left[\frac{\alpha}{h}(T_o - T_i) - \frac{QL}{EI} - \frac{WL^2}{2EI} + \frac{W}{EI\lambda^2}\right] . \qquad (1b)$$

where

$$\lambda = -\sqrt{\frac{H}{EI}} \quad \text{for compression,} \qquad (2)$$

$$\lambda = +\sqrt{\frac{H}{EI}} \quad \text{for tension.}$$

The solution is not yet complete since, in general the axial end load H and hence λ is unknown. An additional compatibility relationship must be employed to evaluate this quantity. Such a relationship is obtained by noting that the change in the spanwise distance between the beam ends due to bending, thermal expansion and mechanical axial strains must be equal to the total change in length of the axial end restraints. This condition can be expressed by

$$\frac{1}{2}\int_0^L (y')^2\,dx \pm \frac{HL}{AE} - \alpha L\left\{\beta T_o + (1-\beta)\,T_i\right\} + \frac{(\pm H - P)}{2K} = 0 \quad , \qquad (3)$$

where positive and negative signs associated with H refer to compression and tension respectively and β defines the location of the centroidal axis (Figure 1.4-1).

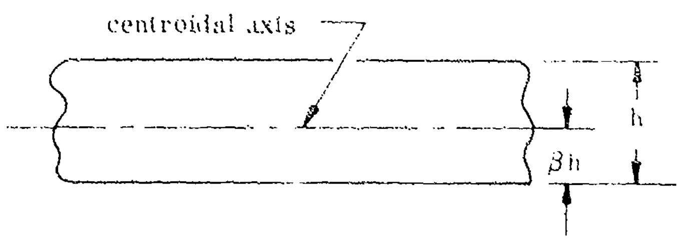

FIGURE 1.4-1 PARAMETER β , DEFINING CENTROIDAL AXIS LOCATION

1.4 (Cont'd)

Substitution of Eqs. (1a) and (1b) into (3) and simplifying yields for the compression case

$$\frac{\tilde{Q}^2}{\bar{\lambda}^5}\left[(\sin\bar{\lambda})\,(\cos^2\frac{\bar{\lambda}}{2}-\frac{5}{2})+\frac{3\bar{\lambda}}{2}\right]$$

$$+\left[\frac{1}{2}-\frac{\sin 2\bar{\lambda}}{4\bar{\lambda}}\right]\left[\frac{1}{\cos^2\bar{\lambda}}\right]\left[\frac{\tilde{W}}{\bar{\lambda}^3}+\frac{\tilde{Q}\sin\bar{\lambda}}{\bar{\lambda}^2}-\frac{\tilde{T}_d}{\bar{\lambda}}\right]^2$$

$$+\frac{\tilde{W}^2}{3\bar{\lambda}^4}-\left[\frac{\tilde{W}}{\bar{\lambda}^3}+\frac{\tilde{Q}\sin\bar{\lambda}}{\bar{\lambda}^2}-\frac{\tilde{T}_d}{\bar{\lambda}}\right]\left[\frac{4\tilde{Q}}{\bar{\lambda}^3\cos\bar{\lambda}}\sin^4(\frac{\bar{\lambda}}{2})\right]$$

$$+\frac{\tilde{Q}\tilde{W}}{\bar{\lambda}^4}\left[1-2\,(\frac{\sin\bar{\lambda}}{\bar{\lambda}}+\frac{\cos\bar{\lambda}}{\bar{\lambda}^2}-\frac{1}{\bar{\lambda}^2})\right] \qquad (4a)$$

$$-\frac{2\tilde{W}}{\bar{\lambda}^4\cos\bar{\lambda}}(\sin\bar{\lambda}-\bar{\lambda}\cos\bar{\lambda})\left[\frac{\tilde{W}}{\bar{\lambda}^3}+\frac{\tilde{Q}\sin\bar{\lambda}}{\bar{\lambda}^2}-\frac{\tilde{T}_d}{\bar{\lambda}}\right]$$

$$+\left[\frac{2I}{AL^2}+\frac{EI}{KL^3}\right]\bar{\lambda}^2=\frac{P}{KL}+2\alpha\left[\beta\,T_o+(1-\beta)\,T_i\right],$$

and for the case of axial tension:

$$\frac{\tilde{Q}^2}{\bar{\lambda}^5}\left[(\sinh\bar{\lambda})\,(\cosh^2\frac{\bar{\lambda}}{2}-\frac{5}{2})+\frac{3\bar{\lambda}}{2}\right]$$

$$-\left[\frac{1}{2}-\frac{\sinh 2\bar{\lambda}}{4\bar{\lambda}}\right]\left[\frac{1}{\cosh^2\bar{\lambda}}\right]\left[-\frac{\tilde{W}}{\bar{\lambda}^3}-\frac{\tilde{Q}\sinh\bar{\lambda}}{\bar{\lambda}^3}+\frac{\tilde{T}_d}{\bar{\lambda}}\right]^2$$

$$+\frac{\tilde{W}^2}{3\bar{\lambda}^4}+\left[\frac{4\tilde{Q}\sinh^4\frac{\bar{\lambda}}{2}}{\bar{\lambda}^3\cosh\bar{\lambda}}\right]\left[-\frac{\tilde{W}}{\bar{\lambda}^3}-\frac{\tilde{Q}\sinh\bar{\lambda}}{\bar{\lambda}^2}+\frac{\tilde{T}_d}{\bar{\lambda}}\right] \qquad (4b)$$

$$+\frac{\tilde{Q}\tilde{W}}{\bar{\lambda}^4}\left[1-2\left(\frac{\sinh\bar{\lambda}}{\bar{\lambda}}-\frac{\cosh\bar{\lambda}}{\bar{\lambda}^2}+\frac{1}{\bar{\lambda}^2}\right)\right]$$

$$+\frac{2\tilde{W}}{\bar{\lambda}^4\cosh\bar{\lambda}}(\sinh\bar{\lambda}-\bar{\lambda}\cosh\bar{\lambda})\left[-\frac{\tilde{W}}{\bar{\lambda}^3}-\frac{\tilde{Q}\sinh\bar{\lambda}}{\bar{\lambda}^2}+\frac{\tilde{T}_d}{\bar{\lambda}}\right]$$

$$-\left(\frac{2I}{AL^2}+\frac{EI}{KL^3}\right)\bar{\lambda}^2=\frac{P}{KL}+2\alpha\left[\beta\,T_o+(1-\beta)\,T_i\right],$$

1.4 (Cont'd)

where

$$\frac{QL^2}{EI} = \tilde{Q}$$

$$\frac{WL^3}{EI} = \tilde{W}$$

$$\lambda L = \bar{\lambda} = +\sqrt{\frac{HL^2}{EI}} \quad \text{for tension}$$

$$= -\sqrt{\frac{HL^2}{EI}} \quad \text{for compression}$$

$$\frac{\alpha L (T_o - T_i)}{h} = \tilde{T}_d \quad .$$

Equations (4a) and (4b) are transcendental equations from which $\bar{\lambda}$ may be determined. Equations (1a) and (1b) then yield the deflections for the known values of $\bar{\lambda}$. In general, Eqs. (4) are difficult to solve except by graphical or trial and error procedures. In addition, presentation of numerical results for the large number of parameters appearing in this general problem is cumbersome. For these reasons, the number of parameters to be used in the presentation of numerical results have been reduced by restricting considerations to the following:

(1) The beam cross section is rectangular and therefore $\beta = \frac{1}{2}$.

(2) The beam is prevented from moving axially at its ends ($K \rightarrow \infty$) or free to move axially ($K = 0$).

(3) The transverse load is either uniform over the span or concentrated at the mid-span.

1.5 NUMERICAL RESULTS FOR BEAMS OF RECTANGULAR CROSS SECTION

CASE A - Uniform transverse load over the span with ends rigidly restrained axially:

The beam is shown schematically in Figure 1.5-1. For this case, we substitute $\tilde{Q} = 0$, $\beta = \frac{1}{2}$, and $\frac{1}{K} = 0$ into Eqs. (1) and (4) of Sub-section 1.4. D[illegible]ing nondimensional quantities:

$$\tilde{W} = \frac{12W}{Eb}\left(\frac{L}{h}\right)^4$$

$$\bar{\lambda} = \pm\sqrt{\frac{HL^2}{EI}} \quad \text{(tension positive)}$$

1.5 (Cont'd)

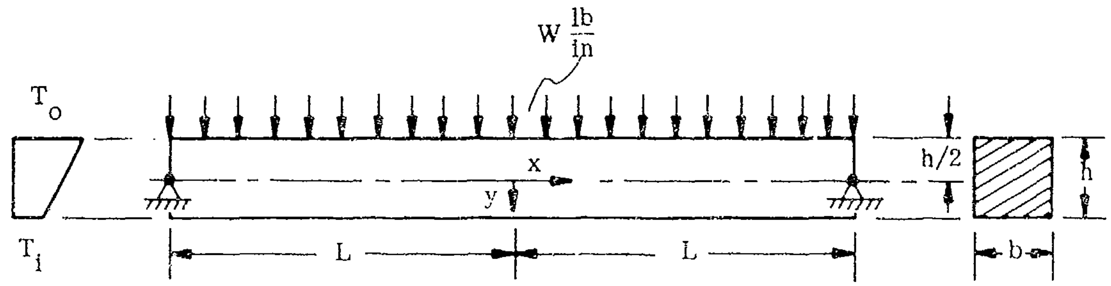

FIGURE 1.5-1 RECTANGULAR BEAM WITH UNIFORM LOAD OVER THE SPAN AND ENDS RIGIDLY RESTRAINED AXIALLY

$$
\begin{aligned}
\bar{T}_d &= \alpha\left(\frac{L}{h}\right)^2 \left(T_o - T_i\right) \\
\bar{T} &= \alpha\left(\frac{L}{h}\right)^2 \left(T_o + T_i\right) \\
\bar{y} &= \left[\frac{y}{h}\right]_{x=0} \\
\bar{M} &= \left[\frac{12ML^2}{Ebh^4}\right]_{x=0} .
\end{aligned}
\qquad (1)
$$

These equations yield

$$
\left[\frac{1}{2} - \frac{\sin 2\bar{\lambda}}{4\bar{\lambda}}\right]\left[\frac{1}{\bar{\lambda}^2\cos^2\bar{\lambda}}\right]\left[\frac{\bar{W}}{\bar{\lambda}^2} - \bar{T}_d\right]^2 + \frac{\bar{W}^2}{3\bar{\lambda}^4}
$$

$$
- \frac{2\bar{W}}{\bar{\lambda}^5\cos\bar{\lambda}}\left(\sin\bar{\lambda} - \bar{\lambda}\cos\bar{\lambda}\right)\left[\frac{\bar{W}}{\bar{\lambda}^2} - \bar{T}_d\right] + \frac{\bar{\lambda}^2}{6} = \bar{T} \qquad (2a)
$$

$$
\begin{aligned}
\bar{y} &= \frac{1}{\bar{\lambda}^2}\left[\frac{\bar{W}}{\bar{\lambda}^2} - \bar{T}_d\right]\left[\frac{1}{\cos\bar{\lambda}} - 1\right] - \frac{\bar{W}}{2\bar{\lambda}^2} \\
\bar{M} &= \left[\frac{\bar{W}}{\bar{\lambda}^2} - \bar{T}_d\right]\left[\frac{1}{\cos\bar{\lambda}} - 1\right] ,
\end{aligned}
\qquad (3a)
$$

for the case of compressive end loads, while for the tensile case

$$- \left[\frac{1}{2} - \frac{\sinh 2\bar{\lambda}}{4\bar{\lambda}}\right] \left[\frac{1}{\bar{\lambda}^2 \cosh^2 \bar{\lambda}}\right] \left[\frac{\bar{W}}{\bar{\lambda}^2} + \bar{T}_d\right]^2 + \frac{\bar{W}^2}{3\bar{\lambda}^4}$$

$$+ \frac{2\bar{W}}{\bar{\lambda}^5 \cosh \bar{\lambda}} (\sinh \bar{\lambda} - \bar{\lambda} \cosh \bar{\lambda}) \left[\frac{\bar{W}}{\bar{\lambda}^2} + \bar{T}_d\right] - \frac{\bar{\lambda}^2}{6} = \bar{T} \tag{2b}$$

$$\bar{y} = \frac{1}{\bar{\lambda}^2}\left[\frac{\bar{W}}{\bar{\lambda}^2} + T_d\right] \left[\frac{1}{\cosh \bar{\lambda}} - 1\right] + \frac{\bar{W}}{2\bar{\lambda}^2}$$

$$\bar{M} = - \left[\frac{\bar{W}}{\bar{\lambda}^2} + \bar{T}_d\right] \left[\frac{1}{\cosh \bar{\lambda}} - 1\right] . \tag{3b}$$

Va' of $\bar{\lambda}$, $\bar{y}$, and $\bar{M}$ for various combinations of $\bar{T}_d$, $\bar{T}$ and $\bar{W}$ are given in Table 1.5-1. This table permits the determination, either directly or by interpolation, of the axial end loads, maximum (central) deflection and maximum bending moment corresponding to specified temperatures and transverse loading. A typical case, extracted from the table is plotted in Figure 1.5-2, showing the variations in end load, central bending moment and deflection with average temperature when the temperature difference and transverse load are held constant.

The figure shows that extremely large values of $\bar{T}$ are required to raise the compressive end load to values in the neighborhood of the critical Euler value, $\bar{\lambda}_{CR} = -\frac{\pi}{2} \approx -1.57$. This is due to the fact that additional beam expansions caused by increasing the average temperature are accommodated by further bending with very little change of compressive end load.

Thus, although the theoretical end load in a perfectly straight axially restrained column reaches the Euler buckling load when $\bar{T} = \frac{\pi^2}{24} \approx .41$, values of $\bar{T}$ several orders of magnitude higher than this can actually be achieved without excessive stresses or deflections occuring. In this respect thermal buckling differs significantly from buckling caused by deadweight loads, since stresses and deflections tend to become excessively large when mechanical loads exceed the Euler buckling value.

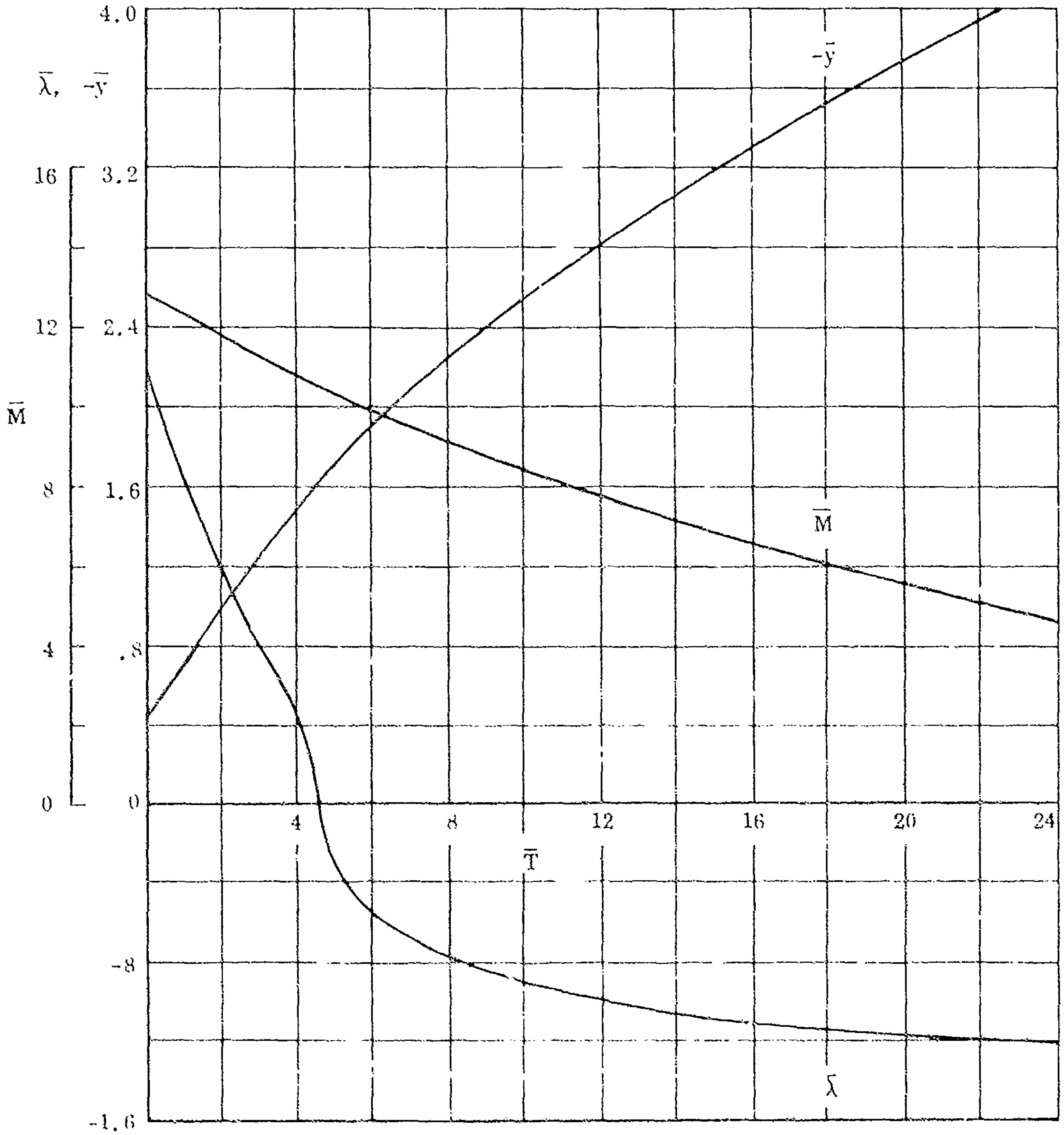

FIGURE 1.5-2 NONDIMENSIONAL END LOAD, CENTRAL DEFLECTION AND MOMENT VS. NONDIMENSIONAL AVERAGE TEMPERATURE; $\bar{W}=21$; $\bar{T}_d=12$

1.5 (Cont'd)

CASE B - Concentrated transverse load at midspan with ends rigidly restrained axially

For this case, we substitute $\overline{W} = 0$, $\beta = \frac{1}{2}$ and $\frac{1}{K} = 0$ into Eqs. (1) and (4) of Sub-section 1.4. Nondimensional quantities are as defined by Eq. (1) and in addition we define

$$\overline{Q} = \frac{12QL^3}{Ebh^4} \quad . \tag{4}$$

$$\begin{aligned} &\frac{\overline{Q}^2}{\overline{\lambda}^5}\left[(\sin\overline{\lambda})\left(\cos^2\frac{\overline{\lambda}}{2} - \frac{5}{2}\right) + \frac{3\overline{\lambda}}{2}\right] \\ &+ \left[\frac{1}{2} - \frac{\sin 2\overline{\lambda}}{4\overline{\lambda}}\right]\left[\frac{1}{\overline{\lambda}^2\cos^2\overline{\lambda}}\right]\left[\frac{Q\sin\overline{\lambda}}{\overline{\lambda}} - \overline{T}_d\right]^2 \\ &- \frac{4\overline{Q}\sin^4\frac{\overline{\lambda}}{2}}{\overline{\lambda}^4\cos\overline{\lambda}}\left[\frac{Q\sin\overline{\lambda}}{\overline{\lambda}} - \overline{T}_d\right] + \frac{\overline{\lambda}^2}{6} = \overline{T} \end{aligned} \tag{5a}$$

$$\begin{aligned} &\overline{y} = \frac{\overline{Q}}{\overline{\lambda}^2}\left(\frac{\tan\overline{\lambda}}{\overline{\lambda}} - 1\right) - \frac{\overline{T}_d}{\overline{\lambda}^2}\left(\frac{1}{\cos\overline{\lambda}} - 1\right) \\ &\overline{M} = \overline{Q}\,\frac{\tan\overline{\lambda}}{\overline{\lambda}} - \overline{T}_d\left[\frac{1}{\cos\overline{\lambda}} - 1\right], \end{aligned} \tag{6a}$$

for the case of compressive end loads, while for the tensile case

$$\begin{aligned} &\frac{\overline{Q}^2}{\overline{\lambda}^5}\left[(\sinh\overline{\lambda})\left(\cosh^2\frac{\overline{\lambda}}{2} - \frac{5}{2}\right) + \frac{3\overline{\lambda}}{2}\right] \\ &\left[\frac{1}{2} - \frac{\sinh 2\overline{\lambda}}{4\overline{\lambda}}\right]\left[\frac{1}{\overline{\lambda}^2\cosh^2\overline{\lambda}}\right]\left[\frac{\overline{Q}\sinh\overline{\lambda}}{\overline{\lambda}} - \overline{T}_d\right]^2 \\ &- \frac{4\overline{Q}\sinh^4\frac{\overline{\lambda}}{2}}{\overline{\lambda}^4\cosh\overline{\lambda}}\left[\frac{\overline{Q}\sinh\overline{\lambda}}{\overline{\lambda}} - \overline{T}_d\right] - \frac{\overline{\lambda}^2}{6} = \overline{T} \end{aligned} \tag{5b}$$

$$\begin{aligned} &\overline{y} = -\frac{\overline{Q}}{\overline{\lambda}^2}\left(\frac{\tanh\overline{\lambda}}{\overline{\lambda}} - 1\right) + \frac{\overline{T}_d}{\overline{\lambda}^2}\left(\frac{1}{\cosh\overline{\lambda}} - 1\right) \\ &\overline{M} = \frac{\overline{Q}\tanh\overline{\lambda}}{\overline{\lambda}} - \overline{T}_d\left[\frac{1}{\cosh\overline{\lambda}} - 1\right] \quad . \end{aligned} \tag{6b}$$

Values of $\overline{\lambda}$, $\overline{y}$, and $\overline{M}$ for various combinations of $\overline{T}_d$, $\overline{T}$ and $\overline{Q}$ are given in Table 1.5-2.

TABLE 1.5-1

VALUES OF $\bar{\lambda}$, y AND $\bar{M}$ FOR SPECIFIED VALUES OF $\bar{T}_d$, $\bar{T}$ AND $\bar{W}$

(Pages 1.12 through 1.37)

TABLE 1.5-1
VALUES OF $\bar{\lambda}$, $\bar{y}$ AND $\bar{M}$ FOR SPECIFIED VALUES OF $\bar{T}_d$, $\bar{T}$ AND $\bar{W}$

$\bar{T}_D$ = 0. $\bar{W}$ = 0.

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.	0.	0.	0.
0.1500000E-01	0.	0.	-0.3000000E-00
0.2666667E-01	0.	0.	-0.4000000E-00
0.4166667E-01	0.	0.	-0.5000000E 00
0.6000000E-01	0.	0.	-0.6000000E 00
0.8166667E-01	0.	0.	-0.7000000E 00
0.1066667E-00	0.	0.	-0.8000000E 00
0.1350000E-00	0.	0.	-0.9000000E 00
0.1666667E-00	0.	0.	-0.1000000E 01
0.2016667E-00	0.	0.	-0.1100000E 01
0.2400000E-00	0.	0.	-0.1200000E 01
0.2816667E-00	0.	0.	-0.1300000E 01
0.3266667E-00	0.	0.	-0.1400000E 01
0.3504167E-00	0.	0.	-0.1450000E 01
0.3750000E-00	0.	0.	-0.1500000E 01
0.4004167E-00	0.	0.	-0.1550000E 01
TENSILE END LOADS			
-0.1500000E-01	0.	0.	0.3000000E-00
-0.2666667E-01	0.	0.	0.4000000E-00
-0.4166667E-01	0.	0.	0.5000000E 00
-0.6000000E-01	0.	0.	0.6000000E 00
-0.8166666E-01	0.	0.	0.7000000E 00
-0.1066667E-00	0.	0.	0.8000000E 00
-0.1350000E-00	0.	0.	0.9000000E 00
-0.1666667E-00	0.	0.	0.1000000E 01
-0.2016667E-00	0.	0.	0.1100000E 01
-0.2400000E-00	0.	0.	0.1200000E 01
-0.2816667E-00	0.	0.	0.1300000E 01
-0.3266667E-00	0.	0.	0.1400000E 01
-0.3750000E-00	0.	0.	0.1500000E 01
-0.4266667E-00	0.	0.	0.1600000E 01
-0.4816667E-00	0.	0.	0.1700000E 01
-0.5400000E 00	0.	0.	0.1800000E 01
-0.6016667E 00	0.	0.	0.1900000E 01
-0.6666667E 00	0.	0.	0.2000000E 01
-0.7350000E 00	0.	0.	0.2100000E 01
-0.8066666E 00	0.	0.	0.2200000E 01
-0.8816666E 00	0.	0.	0.2300000E 01
-0.9600000E 00	0.	0.	0.2400000E 01
-0.1041667E 01	0.	0.	0.2500000E 01
-0.1126667E 01	0.	0.	0.2600000E 01
-0.1215000E 01	0.	0.	0.2700000E 01
-0.1306667E 01	0.	0.	0.2800000E 01
-0.1401667E 01	0.	0.	0.2900000E 01
-0.1500000E 01	0.	0.	0.3000000E 01

$\bar{T}_D$ = 0. $\bar{W}$ = 0.3000000E 01

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.4857143E-00	0.6250000E 00	0.1500000E 01	0.
0.5381333E 00	0.6487420E 00	0.1558387E 01	-0.3000000E-00
0.5820746E 00	0.6684880E 00	0.1606958E 01	-0.4000000E-00
0.6430699E 00	0.6957085E 00	0.1673927E 01	-0.5000000E 00
0.7258127E 00	0.7321367E 00	0.1765569E 01	-0.6000000E 00
0.8378860E 00	0.7804156E 00	0.1882404E 01	-0.7000000E 00
0.9721159E 00	0.8446597E 00	0.2040582E 01	-0.8000000E 00
0.1211392E 01	0.9315309E 00	0.2254540E 01	-0.9000000E 00
0.1539828E 01	0.1052447E 01	0.2552447E 01	-0.1000000E 01
0.2071767E 01	0.1228614E 01	0.2986622E 01	-0.1100000E 01
0.3041085E 01	0.1504201E 01	0.3666049E 01	0.1200000E 01
0.5173938E 01	0.1988727E 01	0.4860946E 01	-0.1300000E 01
0.1181068E 02	0.3048331E 01	0.7474729E 01	-0.1400000E 01
0.2255509E 02	0.4239773E 01	0.1041412E 02	-0.1450000E 01
0.6293117E 02	0.7110123E 01	0.1751578E 02	-0.1500000E 01
0.7023224E 03	0.2385009E 02	0.5879985E 02	-0.[illegible]00E 01
TENSILE END LOADS			
0.4375623E-00	0.6029302E 00	0.1445736E 01	0.3000000E-00
0.4016713E-00	0.5868110E 00	0.1406110E 01	0.4000000E-00
0.3587850E-00	0.5673065E 00	0.1358173E 01	0.5000000E 00
0.3079202E-00	0.5451549E 00	0.1303[illegible]E 01	0.6000000E 00
0.2564499E-00	0.5211012E 00	0.1244660E 01	0.7000000E 00
0.1996001E-00	0.4758490E-00	0.1182657E 01	0.8000000E 00
0.1[illegible]3246E-00	0.4700258E-00	0.1119279E 01	0.9000000E 00
0.[illegible]735E-01	0.4441628E-00	0.1055037E 01	0.1000000E 01
0.1703176E-01	0.4186087E-00	0.9933866E 00	0.1100000E 01
-0.4628358E-01	0.3937325E-00	0.9327372E 00	0.1200000E 01
-0.1105412E-00	0.3701328E-00	0.8754756E 00	0.1300000E 01
-0.1757703E-00	0.3474505E-00	0.8189969E 00	0.1400000E 01
-0.2420[illegible]E-00	0.3259828E-00	0.7665306E 00	0.1500000E 01
-0.3096274E-00	0.3057761E-00	0.7172131E 00	0.1600000E 01
-0.3785962[illegible] 00	0.2868303E-00	0.6710374E 00	0.1700000E 01
-0.4491779E-00	0.2691486E-00	0.6279584E 00	0.1800000E 01
-0.5215618E 00	0.2526665E-00	0.5878739E 00	0.1900000E 01
-0.5959263E 00	0.2373379E-00	0.5506483E 00	0.2000000E 01
-0.672[illegible]80E 00	0.2231006E-00	0.5161262E 00	0.2100000E 01
-0.75[illegible]E 00	0.2098891E-00	0.4841414E-00	0.2200000E 01
-0.8324[illegible] 00	0.1976325E-00	0.4545243E-00	0.2300000E 01
-0.9162737E 00	0.1862652E-00	0.4273068E-00	0.2400000E 01
-0.1002714E 01	0.1757232E-00	0.4017258E-00	0.2500000E 01
-0.1091098E 01	0.1659430E-00	0.3782254E-00	0.2600000E 01
-0.1163902E 01	0.1568644E-00	0.3564582E-00	0.2700000E 01
-0.1278796E 01	0.1484329E-00	0.3362962E-00	0.2800000E 01
0.1376638E 01	0.1405960E-00	0.3175811E-00	0.2900000E 01
-0.1477478E 01	0.1333094E-00	0.3002240E-00	0.3000000E 01

$\bar{T}_D$ = 0. $\bar{W}$ = 0.6000000E 01

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.[illegible]428571E 01	0.1250000E 01	0.3000000E 01	0.
0.2107533E 01	0.1297584E 01	0.3116774E 01	-0.3000000E-00
0.2248279E 01	0.1336976E 01	0.3213916E 01	0.4000000E-00
0.2447280E 01	0.1391471E 01	0.3347854E 01	0.5000000E 00
0.2723251E 01	0.1464273E [illegible]	0.3527138E 01	-0.6000000E 00
0.3106547E 01	0.1560851E 01	0.3765807E 01	-0.7000000E 00
0.3648468E 01	0.1689319E 01	0.4081[illegible]64E 01	-0.8000000E 00
0.4440569E 01	0.1863062E 01	0.4509080E 01	-0.9000000E 00
0.5659311E 01	0.2104894E 01	0.5104894E 01	-0.1000000E 01
0.7682066E 01	0.2457227E 01	0.5973245E 01	0.1100000E 01
0.1144436E 02	0.3008401E 01	0.7332098E 01	-0.1200000E 01
0.1963075E 02	0.3977453E 01	0.9721096E 01	-0.1300000E 01
0.4626271E 02	0.6096663E 01	0.1494946E 02	-0.1400000E 01
0.8916910E 02	0.8475454E 01	0.2082024E 02	0.1450000E 01
0.2505997E 03	0.1423625E 02	0.3503155E 02	0.1500000E 01
0.2808088E 04	0.4770018E 02	0.1175997E 03	-0.1550000E 01
TENSILE END LOADS			
0.1795249E 01	0.1265860E 01	0.2891473E 01	0.3000000E 00
0.1686605E 01	0.1173622E 01	0.2812220E 01	0.4000000E 00
0.1560140E 01	0.1134613E 01	0.2716347E 01	0.5000000E 00
0.1419681E 01	0.1090310E 01	0.2607488E 01	0.6000000E 00
0.1270800E 01	0.1042202E 01	0.2489321E 01	0.7000000E 00
0.1118401E 01	0.9916981E 00	0.2365313E 01	0.8000000E 00
0.9662964E 00	0.9400515E 00	0.2238559E 01	0.9000000E 00
0.8172695E 00	0.8803256E 00	0.2111674E 01	0.1000000E 01
0.6731270E 00	0.8373775E 00	0.1985774E 01	0.1100000E 01
0.5348657E 00	0.7878650E 00	0.1865474E 01	0.1200000E 01
0.4028352E-00	0.7402656E 00	0.1748951E 01	0.1300000E 01
0.2769189E-00	0.6949011E 00	0.1637794E 01	0.1400000E 01
0.1566808E-00	0.65196[illegible] 00	0.1533077E 01	0.1500000E 01
0.4149075E-01	0.6115523E 00	0.14[illegible]426E 01	0.1600000E 01
-0.6938487E-01	0.5736766E 00	0.13[illegible]075E 01	0.1700000E 01
-0.1767115E-00	0.5382973E 00	0.1255917E 01	0.1800000E 01
-0.2812458E-00	0.5053330E 00	0.1175768E 01	0.1900000E 01
-0.3037053E 00	0.4746750E 00	0.1101297E 01	0.2000000E 01
-0.4047522E-00	0.4462017E-00	0.1032252E 01	0.2100000E 01
-0.5849862E 00	0.4191763E-00	0.9682028E 00	0.2200000E 01
-0.6849627E 00	0.3952449E-00	0.9090488E 00	0.2300000E 01
-0.7850940E 00	0.37[illegible]324E-00	0.8542136E 00	0.2400000E 01
-0.8858570E 00	0.[illegible]4477E-00	0.8034516E 00	0.2500000E 01
-0.9875900E 00	0.3318860E-00	0.7564507E 00	0.2600000E 01
-0.1090610E 01	0.3137289E-00	0.7129163E 00	0.2700000E 01
-0.1195185E 01	0.2968658E-00	0.6725724E 00	0.2800000E 01
-0.1301552E 01	0.2011936E-00	0.6351622E 00	0.2900000E 01
-0.1409912E 01	0.2666169E-00	0.6004480E 00	0.3000000E 01

$\bar{T}_D$ = 0. $\bar{W}$ = 0.9000000E 01

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.4371428E 01	0.1875000E 01	0.4500000E 01	0.
0.4723277E 01	0.1946226E 01	0.4675160E 01	0.3000000E 00
0.5025325E 01	0.2005464E 01	0.4820474E 01	0.4000000E 00
0.5454295E 01	0.2087125E 01	0.5021781E 01	0.5000000E 00
0.6005231E 01	0.2196410E 01	0.5293708E 01	0.6000000E 00
0.6887649E 01	0.2341267E 01	0.5647221E 01	0.7000000E 00
0.8075716E 01	0.2553727E 01	0.6121767E 01	0.8000000E 00
0.9822550E 01	0.2774592E 01	0.6763626E 01	0.9000000E 00
0.1252512E 02	[illegible]	0.7657342E 01	0.1000000E 01
0.1763257E 02	[illegible]	0.8959867E 01	0.1100000E 01
0.2560425E 02	0.4512692E 01	[illegible]	0.1200000E 01
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	0.1809723E 01	[illegible]	[illegible]
0.3820372E 01	0.1750433E 01	0.4210133E 01	[illegible]
0.3562402E 01	[illegible]	[illegible]	[illegible]
0.3269200E 01	0.1655465E 01	0.3911233E 01	[illegible]
0.2921383E 01	0.1563504E 01	0.3733281E 01	[illegible]
0.2642734E 01	0.1487547E 01	0.3554770E 01	[illegible]
0.2362921E 01	0.1410377E 01	0.3357837E 01	[illegible]
0.2047109E 01	0.1332488E 01	0.3167512E 01	[illegible]
0.1766619E 01	0.1256066E 01	[illegible]	0.1100000E 01
0.1503448E 01	0.1181792E 01	[illegible]	0.1200000E 01
0.1258463E 01	0.1110398E 01	0.2673627E 01	0.1300000E 01
0.1031403E 01	0.1042352E 01	0.2456921E 01	0.1400000E 01
0.8212010E 00	0.9779685E 00	0.2299616E 01	0.1500000E 01
0.6266863E 00	0.9173215E 00	0.2151659E [illegible]	0.1600000E 01
0.4453676E 00	0.8605149E 00	0.2013112E 01	0.1700000E 01
0.2773291E-00	0.8074459E 00	0.1883875E 01	0.1800000E 01
0.1192802E-00	0.7577295E 00	0.1763622E 01	[illegible]
[illegible]	0.7120130E 00	0.1651965E 01	[illegible]
0.1719624E 00	0.6693712E 00	0.1548379E 01	0.2100000E 01
0.3078856E 00	0.6296644E 00	0.1452424E 01	[illegible]
0.4390378E 00	0.5928974E 00	0.1363573E 01	[illegible]
0.5666413E 00	0.5507965E 00	0.1281320E 01	0.2400000E 01
0.6910950E 00	0.5271716E 00	0.1205177E 01	0.2500000E 01
0.8137460E 00	0.4973290E 00	0.1134678E 01	0.2600000E 01
0.9351[illegible]E 00	0.4705933E 00	0.1069174E 01	0.2700000E 01
-0.1055816E 01	0.4452985E-00	0.1003359E 01	0.2800000E 01
0.1176409E 01	0.4217903E 00	0.9527434E 00	0.2900000E 01
0.1297302E 01	0.3999253E 00	0.9006721E 00	0.3000000E 01

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TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = 0. $\overline{W}$ = 0.1200000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.777' 'E 01	0.2500000E 01	0.6000000E 01	0.
0.8385 E 01	0.2594968E 01	0.6233547E 01	-0.3000000E-00
0.8913194E 01	0.2673952E 01	0.6427832E 01	-0.4000000E-00
0.9664118E 01	0.2782834E 01	0.6695703E 01	-0.5000000E 00
0.1071300E 02	0.2928547E 01	0.7054277E 01	-0.6000000E 00
0.1218119E 02	0.3121662E 01	0.7529615E 01	-0.7000000E 00
0.1427387E 02	0.3378639E 01	0.8162329E 01	-0.8000000E 00
0.1735728E 02	0.3726124E 01	0.9018160E 01	-0.9000000E 00
0.2213724E 02	0.4209789E 01	0.1029179E 02	-0.1000000E 01
0.3012327E 02	0.4914454E 01	0.119460 02	-0.1100000E 01
0.4505736E 02	0.6016803E 01	0.1466420E 02	-0.1200000E 01
0.7855800E 02	0.7954907E 01	0.1944379E 02	-0.1300000E 01
0.1840708E 03	0.1219333E 02	0.2982872E 02	-0.1400000E 01
0.3556257E 03	0.1695909E 02	0.4165649E 02	-0.1450000E 01
0.1001274E 04	0.2847249E 02	0.7036311E 02	-0.1500000E 01
0.1123115E 05	0.9542037E 02	0.2351994E 03	-0.1550000E 01
TENSILE END LOADS			
0.7225997E 01	0.2411721E 01	0.5782945E 01	0.3000000E-00
0.6826740E 01	0.2347244E 01	0.5624441E 01	0.4000000E-00
0.6365560E 01	0.2269226E 01	0.5432693E 01	0.5000000E 00
0.5858724E 01	0.2180620E 01	0.5214977E 01	0.6000000E 00
0.5328199E 01	0.2084405E 01	0.4978642E 01	0.7000000E 00
0.4793602E 01	0.1983396E 01	0.4730626E 01	0.8000000E 00
0.4270193E 01	0.1880103E 01	0.4477116E 01	0.9000000E 00
0.3769078E 01	0.1776651E 01	0.4223349E 01	0.1000000E 01
0.3297508E 01	0.1676755E 01	0.3973547E 01	0.1100000E 01
0.2859463E 01	0.1575730E 01	0.3730949E 01	0.1200000E 01
0.2456147E 01	0.1480533E 01	0.3497702E 01	0.1300000E 01
0.2087675E 01	0.1389802E 01	0.3275988E 01	0.1400000E 01
0.1751723E 01	0.1303933E 01	0.3066154E 01	0.1500000E 01
0.1445961E 01	0.1223105E 01	0.2868452E 01	0.1600000E 01
0.1167460E 01	0.1147353E 01	0.2685149E 01	0.1700000E 01
0.9131540E 00	0.1076595E 01	0.2511634E 01	0.1800000E 01
0.6800167E 00	0.1010686E 01	0.2351496E 01	0.1900000E 01
0.4651786E 00	0.9493517E 00	0.2202593E 01	0.2000000E 01
0.2659913E-00	0.8924026E 00	0.2064505E 01	0.2100000E 01
0.8005519E-01	0.8395526E 00	0.1936565E 01	0.2200000E 01
-0.9477098E-01	0.7905229E 00	0.1818097E 01	0.2300000E 01
-0.2603793E-00	0.7450647E 00	0.1708427E 01	0.2400000E 01
-0.4184282E-00	0.7028955E 00	0.1606903E 01	0.2500000E 01
-0.5703633E 00	0.6637720E 00	0.1512701E 01	0.2600000E 01
-0.7174392E 00	0.6274578E 00	0.1425633E 01	0.2700000E 01
-0.8607417E 00	0.5937315E 00	0.1345165E 01	0.2800000E 01
-0.1001208E 01	0.5623871E 00	0.1270324E 01	0.2900000E 01
-0.1139668E 01	0.5332338E 00	0.1200834E 01	0.3000000E 01

$\overline{T}_D$ = 0. $\overline{W}$ = 0.1500000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0. 4286E 02	0.3125000E 01	0.7500000E 01	0.
0.1209345E 02	0.3243710E 01	0.7791934E 01	-0.3000000E-00
0.1391189E 02	0.3342440E 01	0.8034790E 01	-0.4000000E-00
0.1507676E 02	0.3478542E 01	0.8369636E 01	-0.5000000E 00
0.1670530E 02	0.3660685E 01	0.8817846E 01	-0.6000000E 00
0.1898718E 02	0.3902076E 01	0.9412018E 01	-0.7000000E 00
0.2224291E 02	0.4223799E 01	0.1020291E 02	-0.8000000E 00
0.2704481E 02	0.4657656E 01	0.1127770E 02	-0.9000000E 00
0.3449569E 02	0.5262236E 01	0.1276224E 02	-0.1000000E 01
0.4695417E 02	0.6143068E 01	0.1493311E 02	-0.1100000E 01
0.7026712E 02	0.7521004E 01	0.1833024E 02	-0.1200000E 01
0.1225884E 03	0.9943633E 01	0.2430474E 02	-0.1300000E 01
0.2874269E 03	0.1524166E 02	0.3737365E 02	-0.1400000E 01
0.5556772E 03	0.2119886E 02	0.5207061E 02	-0.1450000E 01
0.1564279E 04	0.3559062E 02	0.8757889E 02	-0.1500000E 01
0.1754845E 05	0.1192505E 03	0.2939992E 03	-0. 500000E 01
TENSILE END LOADS			
0.1129012E 02	0.3014651E 01	0.7228681E 01	0.3000000E-00
0.1066818E 02	0.2934055E 01	0.7030551E 01	0.4000000E-00
0.9969440E 01	0.2836533E 01	0.6790867E 01	0.5000000E 00
0.9188004E 01	0.2725775E 01	0.6518721E 01	0.6000000E 00
0.8371245E 01	0.2605506E 01	0.6223302E 01	0.7000000E 00
0.7550004E 01	0.2479245E 01	0.5913283E 01	0.8000000E 00
0.6748115E 01	0.2350129E 01	0.5596396E 01	0.9000000E 00
0.5982933E 01	0.2220814E 01	0.5279186E 01	0.1000000E 01
0.5265794E 01	0.2093444E 01	0.4966933E 01	0.1100000E 01
0.4602910E 01	0.1969663E 01	0.4663686E 01	0.1200000E 01
0.3996470E 01	0.1850664E 01	0.4372378E 01	0.1300000E 01
0.3445753E 01	0.1737253E 01	0.4094985E 01	0.1400000E 01
0.2948005E 01	0.1629914E 01	0.3832693E 01	0.1500000E 01
0.2499314E 01	0.1528081E 01	0.3586065E 01	0.1600000E 01
0.2095094E 01	0.1434191E 01	0.3355187E 01	0.1700000E 01
0.1730553E 01	0.1345743E 01	0.3139772E 01	0.1800000E 01
0.1400964E 01	0.1263533E 01	0.2939701E 01	0.1900000E 01
0.1101842E 01	0.1186690E 01	0.2753242E 01	0.2000000E 01
0.8290486E 00	0.1115503E 01	0.2580641E 01	0.2100000E 01
0.5788162E 00	0.1049441E 01	0.2420707E 01	0.2200000E 01
0.3478578E-00	0.9881623E 00	0.2272671E 01	0.2300000E 01
0.1331574E-00	0.9313309E 00	0.2135534E 01	0.2400000E 01
-0.6785659E-01	0.8786193E 00	0.2008329E 01	0.2500000E 01
-0.2576427E-00	0.8297150E 00	0.1903127E 01	0.2600000E 01
-0.4375615E-00	0.7843223E 00	0.1782291E 01	0.2700000E 01
-0.6099088E 00	0.7421644E 00	0.1681451E 01	0.2800000E 01
-0.7759508E 00	0.7029839E 00	0.1587906E 01	0.2900000E 01
-0.9365508E 00	0.6665422E 00	0.1501120E 01	0.3000000E 01

$\overline{T}_D$ = 0. $\overline{W}$ = 0.1800000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1748571E 02	0.3750000E 01	0.9000000E 01	0.
0.1884811E 02	0.3892452E 01	0.9350321E 01	-0.3000000E-00
0.2002129E 02	0.4010923E 01	0.9641749E 01	-0.4000000E-00
0.2169218E 02	0.4174251E 01	0.1004356E 02	-0.5000000E 00
0.2402924E 02	0.4392820E 01	0.1058164E 02	-0.6000000E 00
0.2730559E 02	0.4682494E 01	0.1129442E 02	0.7000000E 00
0.3190287E 02	0.5067958E 01	0.1224349E 02	0.8000000E 00
0.3868512E 02	0.5589185E 01	0.1352724E 02	-0.9000000E 00
0.4960047E 02	0.6314683E 01	0.1531465E 02	0.1000000E 01
0.6752528E 02	0.7371681E 01	0.1791973E 02	0.1100000E 01
0.1010791E 03	0.9025204E 01	0.2199629E 02	0.1200000E 01
0.1764034E 03	0.1193236E 02	0.2916569E 02	0.1300000E 01
0.4137510E 03	0.1828999E 02	0.4484510E 02	0.1400000E 01
0.7997186E 03	0.2543864E 02	0.6248473E 02	0.1450000E 01
0.2252397E 04	0.4270874E 02	0.1050947E 03	0.1500000E 01
0.2526959E 05	0.1431005E 03	0.3527791E 03	0.1550000E 01
TENSILE END LOADS			
0.1627748E 02	0.3617582E 01	0.8674419E 01	0.3000000E-00
0.1519169E 02	0.3520846E 01	0.8436561E 01	0.4000000E-00
0.1417461E 02	0.3403539E 01	0.8148040E 01	0.5000000E 00
0.1325712E 02	0.3270930E 01	0.7822465E 01	0.6000000E 00
0.1209053E 02	0.3126607E 01	0.7467962E 01	0.7000000E 00
0.1091894E 02	0.2975094E 01	0.7095940E 01	0.8000000E 00
0.9776685E 01	0.2820155E 01	0.6715675E 01	0.9000000E 00
0.8688736E 01	0.2664977E 01	0.6335023E 01	0.1000000E 01
0.7671476E 01	0.2512132E 01	0.5960320E 01	0.1100000E 01
0.6733721E 01	0.2363595E 01	0.5596423E 01	0.1200000E 01
0.5870850E 01	0.2220797E 01	0.5246854E 01	0.1300000E 01
0.5105605E 01	0.2084721E 01	0.4913902E 01	0.1400000E 01
0.4410127E 01	0.1955097E 01	0.4599232E 01	0.1500000E 01
0.3786745E 01	0.1834657E 01	0.4303278E 01	0.1600000E 01
0.3228069E 01	0.1721030E 01	0.4026224E 01	0.1700000E 01
0.2729596E 01	0.1614892E 01	0.3767751E 01	0.1800000E 01
0.2282127E 01	0.1515999E 01	0.3527245E 01	0.1900000E 01
0.1879985E 01	0.1424027E 01	0.3303589E 01	0.2000000E 01
0.1517230E 01	0.1338034E 01	0.3096757E 01	0.2100000E 01
0.1188457E 01	0.1259129E 01	0.2904858E 01	0.2200000E 01
0.8888486E 00	0.1185795E 01	0.2727146E 01	0.2300000E 01
0.6141467E 00	0.1117587E 01	0.2562841E 01	0.2400000E 01
0.3606190E 00	0.1054463E 01	0.2410355E 01	0.2500000E 01
0.1271159E 00	0.9956580E 00	0.2269352E 01	0.2600000E 01
-0.9548529E-01	0.9411867E 00	0.2138749E 01	0.2700000E 01
-0.3033355E 00	0.8905973E 00	0.2017112E 01	0.2800000E 01
0.5006358E 00	0.8435507E 00	0.1903487E 01	0.2900000E 01
-0.6892092E 00	0.7998507E 00	0.1801344E 01	0.3000000E 01

$\overline{T}_D$ = 0. $\overline{W}$ = 0.2100000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.2380000E 02	0.4375000E 01	0.1050000E 02	0.
0.2568559E 02	0.4541195E 01	0.1090871E 02	0.1000000E-00
0.2724146E 02	0.4679414E 01	0.1124671E 02	-0.4000000E-00
0.2951035E 02	0.4869959E 01	0.1171749E 02	0.5000000E 00
0.3268479E 02	0.5124957E 01	0.1234498E 02	0.6000000E 00
0.3711545E 02	0.5462904E 01	0.1317483E 02	0.7000000E 00
0.4347213E 02	0.5912618E 01	0.1428408E 02	0.8000000E 00
0.5287021E 02	0.6520715E 01	0.1578178E 02	0.9000000E 00
0.6745155E 02	0.7367113E 01	0.1786711E 02	-0. 000000E 01
0.9183458E 02	0.8600295E 01	0.2090634E 02	0.1100000E 01
0.1374932E 03	0.1052940E 02	.2566234E 02	0.1200000E 01
0.2400050E 03	0.1392109E 02	0.3403464E 02	0.1300000E 01
0.5630447E 03	0.2133832E 02	0.5232111E 02	0.1400000E 01
0.1088119E 04	0.2967341E 02	0.7289685E 02	-0.1450000E 01
0.3056201E 04	0.4992680E 02	0.1226104E 03	0.1500000E 01
0.3439456E 05	0.1669526E 03	0.4115989E 03	0.1550000E 01
TENSILE END LOADS			
0.2216262E 02	0.4220512E 01	0.1012015E 02	0.3000000E-00
0.2026192E 02	0.4107677E 01	0.9842772E 01	0.4000000E 00
0.1925053E 02	0.3971146E 01	0.9501714E 01	0.5000000E 00
0.1800658E 02	0.3816285E 01	0.9126239E 01	0.6000000E 00
0.1644305E 02	0.3447708E 01	0.8712621E 01	0.7000000E 00
0.1470341E 02	0.3470943E 01	0.8278596E 01	0.8000000E 00
0.1333559E 02	0.3290180E 01	0.7834954E 01	0.9000000E 00
0.1198655E 02	0.3109140E 01	0.7390860E 01	0.1000000E 01
0.1051454E 02	0.2930421E 01	0.6953706E 01	0.1100000E 01
0.9252105E 01	0.2757528E 01	0.6529140E 01	0.1200000E 01
0.8103481E 01	0.2590422E 01	0.6121329E 01	0.1300000E 01
0.7067256E 01	0.2432154E 01	0.5732079E 01	0.1400000E 01
0.6139099E 01	0.2281080E 01	0.5364771E 01	0.1500000E 01
0.5309255E 01	0.2140453E 01	0.5020491E 01	0.1600000E 01
0.4568785E 01	0.2007068E 01	0.4697261E 01	0.1700000E 01
0.3910294E 01	0.1880640E 01	0.4395709E 01	0.1800000E 01
0.3371480E 01	0.1758466E 01	0.4115111E 01	0.1900000E 01
0.2799610E 01	0.1644165E 01	0.3054538E 01	0.2000000E 01
0.2330536E 01	0.1561704E 01	0.3612883E 01	0.2100000E 01
0.1938914E 01	0.1469217E 01	0.3388490E 01	0.2200000E 01
0.1528201E 01	0.1383427E 01	0.3181470E 01	0.2300000E 01
0.1182558E 01	0.1103946E 01	0.2989774E 01	0.2400000E 01
0.8670011E 00	0.1230067E 01	0.2812081E 01	0.2500000E 01
0.5772123E 00	0.1161401E 01	0.2647578E 01	0.2600000E 01
0.3081779E 00	0.1098051E 01	0.2495207E 01	0.2700000E 01
0.5897850E-01	0.1039010E 01	0.2354003E 01	0.2800000E 01
0.1752635E-00	0.9841774E 00	0.2223268E 01	0.2900000E 01
0.3944236E 00	0.7331591E 00	0.2101568E 01	0.3000000E 01

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = 0. $\overline{W}$ = 0.2400000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.3108571E 02	0.5000000E 01	0.1200000E 02	0.
0.3349555E 02	0.5189938E 01	0.1248709E 02	-0.3000000E-00
0.3557278E 02	0.5347904E 01	0.1285566E 02	-0.4000000E-00
0.3855147E 02	0.5565668E 01	0.1339142E 02	-0.5000000E 00
0.4267201E 02	0.5857093E 01	0.1410055E 02	-0.6000000E 00
0.4347975E 02	0.6243325E 01	0.1505923E 02	0.7000000E 00
0.5677548E 02	0.6757277E 01	0.1632466E 02	-0.8000000E 00
0.6902410E 02	0.7452247E 01	0.1803652E 02	0.9000000E 00
0.8804897E 02	0.8419577E 01	0.2041758E 02	0.1000000E 01
0.1198881E 03	0.9828909E 01	0.2389298E 02	0.1100000E 01
0.1795094E 03	0.1203361E 02	0.2932839E 02	0.1200000E 01
0.3133870E 03	0.1590981E 02	0.3908758E 02	.1300000E 01
0.7353033E 03	0.2438665E 02	0.5972783E 02	0.1400000E 01
0.1421449E 04	0.3391818E 02	0.8331297E 02	-0.1450000E 01
0.4003970E 04	0.5694492E 02	0.1401262E 03	-0.1500000E 01
0.4492341E 05	0.1908007E 03	0.4703708E 03	-0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.2894699E 02	0.4823442E 01	0.1156589E 02	0.3000000E 00
0.2738696E 02	0.4694488E 01	0.1124880E 02	0.4000000E-00
0.2558724E 02	0.4518452E 01	0.1086519E 02	0.5000000E 00
0.2361489E 02	0.4361239E 01	0.1042795E 02	0.6000000E 00
0.2155779E 02	0.4160913E 01	0.9957283E 01	0.7000000E 00
0.1959645E 02	0.3966792E 01	0.9461255E 01	0.8000000E 00
0.1743577E 02	0.3760298E 01	0.8954233E 01	0.9000000E 00
0.3557651E 02	0.3553103E 01	0.8446637E 01	0.1000000E 01
0.1379503E 02	0.3349510E 01	0.7947073E 01	0.1100000E 01
0.1215785E 02	0.3151459E 01	0.7461497E 01	0.1200000E 01
0.1067036E 02	0.2961062E 01	0.6995825E 01	0.1300000E 01
0.9330702E 01	0.2779604E 01	0.6551276E 01	0.1400000E 01
0.8131492E 01	0.2607843E 01	0.6132509E 01	0.1500000E 01
0.7063844E 01	0.2446309E 01	0.5737704E 01	0.1600000E 01
0.6114842E 01	0.2294706E 01	0.5368299E 01	0.1700000E 01
0.5272616E 01	0.2151182E 01	0.5023558E 01	0.1800000E 01
0.4525067E 01	0.2021332E 01	0.4702229E 01	0.1900000E 01
0.3860715E 01	0.1898723E 01	0.4405147E 01	0.2000000E 01
0.3258965E 01	0.1784905E 01	0.4129939E 01	0.2100000E 01
0.2740221E 01	0.1679105E 01	0.3873113E 01	0.2200000E 01
0.2265916E 01	0.1581060E 01	0.3636194E 01	0.2300000E 01
0.1838483E 01	0.1490129E 01	0.3415955E 01	0.2400000E 01
0.1451287E 01	0.1405791E 01	0.3211803E 01	0.2500000E 01
0.1098587E 01	0.1327554E 01	0.3022568E 01	0.2600000E 01
0.7752430E 00	0.1254216E 01	0.2845155E 01	0.2700000E 01
0.4770333E 00	0.1187453E 01	0.2692290E 01	0.2800000E 01
0.2021660E 00	0.1124777E 01	0.2540684E 01	0.2900000E 01
0.5854414E 01	0.1065867E 01	0.2401792E 01	0.3000000E 01

$\overline{T}_D$ = 0.4000000E 01 $\overline{W}$ = 0.

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.5333333E 01	-0.2000000E 01	0.	0.
0.5754387E 01	-0.2077869E 01	-0.1870064E-00	-0.3000000E-00
0.6115220E 01	-0.2142611E 01	-0.3428177E-00	-0.4000000E-00
0.6628593E 01	-0.2231903E 01	-0.5579757E 00	-0.5000000E 00
0.7344781E 01	-0.2351476E 01	-0.9465142E 00	-0.6000000E 00
0.8345840E 01	-0.2509871E 01	-0.1229837E 01	-0.7000000E 00
0.9770509E 01	-0.2720778E 01	-0.1761297E 01	-0.8000000E 00
0.1186658E 02	-0.3006053E 01	0.2436703E 01	-0.9000000E 00
0.1511156E 02	-0.3403253E 01	0.3403263E 01	-0.1000000E 01
0.20526 [illegible] 02	-0.3982163E 01	-0.4818417E 01	-0.1100000E 01
0.3064280E 02	-0.4888065E 01	-0.7038814E 01	0.1200000E 01
0.5331974E 02	-0.6481264E 01	0.1095334E 02	-0.1300000E 01
0.1247108E 03	-0.9966306E 01	0.1955396E 02	-0.1400000E 01
0.2407679E 03	0.1388550E 02	-0.2919625E 02	-0.1450000E 01
0.6775274E 03	0.2335437E 02	0.5254733E 02	-0.1500000E 01
0.7527559E 04	-0.7839779E 02	0.1883555E 03	-0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.4255434E 01	0.1927648E 01	0.1734883E-00	0.3000000E-00
0.4605013E 01	0.1874015E 01	0.2999702E 00	0.4000000E-00
0.4367503E 01	0.1810998E 01	0.4527245E 00	0.5000000E 00
0.4017885E 01	0.1738126E 01	0.6257972E 00	0.6000000E 00
0.3651279E 01	0.1659587E 01	0.8131781E 00	0.7000000E 00
0.3280718E 01	0.1576075E 01	0.1007230E 01	0.8000000E 00
0.2916547E 01	0.1492372E 01	0.1208821E 01	0.9000000E 00
0.2586292E 01	0.1407703E 01	0.1407783E 01	0.1000000E 01
0.2234863E 01	0.1324515E 01	0.1602564E 01	0.1100000E 01
0.1924957E 01	0.1243550E 01	0.1790855E 01	0.1200000E 01
0.1637532E 01	0.1165967E 01	0.1970485E 01	0.1300000E 01
0.1372270E 01	0.1091926E 01	0.2140312E 01	0.1400000E 01
0.1128024E 01	0.1022051E 01	0.2299616E 01	0.1500000E 01
0.9030701E 00	0.9562846E 00	0.2448092E 01	0.1600000E 01
0.6958427E 00	0.8947155E 00	0.2585731E 01	0.1700000E 01
0.5030763E 00	0.8372279E 00	0.2712780E 01	0.1800000E 01
0.3239265E 00	0.7836519E 00	0.2829851E 01	0.1900000E 01
0.1580593E 00	0.7341974E 00	0.2936772E 01	0.2000000E 01
0.2337124E [illegible]	0.6880169E 00	0.3034822E 01	0.2100000E 01
0.1527918E 00	0.6455219E 00	0.3112432E 01	0.2200000E 01
0.2758382E 00	0.6060324E 00	0.3205011E 01	0.2300000E 01
0.4357212E 00	0.5694757E 00	0.3290140E 01	0.2400000E 01
0.5705587E 00	0.5356144E 00	0.3367715E 01	0.2500000E 01
0.7021230E 00	0.5041335E 00	[illegible]	0.2600000E 01
0.8318603E 00	0.4752275E 00	0.3506477E 01	0.2700000E 01
0.9590281E 00	0.4483416E 00	0.3551531E 01	0.2800000E 01
0.1047089E 01	0.4236415E 00	0.3561148E 01	0.2900000E 01
0.1211939E 01	0.4002248E 00	0.3622599E 01	0.3000000E 01

$\overline{T}_D$ = 0.4000000E 01 $\overline{W}$ = [illegible]

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	0.
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = [illegible] 01 $\overline{W}$ = 0.6000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	0.
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-1 (Cont'd)

VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = 0.4000000E 01 $\overline{W}$ = 0.9000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1047620E 00	0.1250000E 00	0.4500000E 01	0.
0.1229261E-00	-0.1311622E-00	0.4488154E 01	-0.1000000E-00
0.1301364E 00	-0.1371472E-00	0.4478056E 01	-0.4000000E-00
0.1574885E-00	-0.1447773E 00	0.4463806E 01	0.5000000E 00
0.1917661E-00	-0.1550157E-00	0.4444194E 01	-0.6000000E 00
0.2114314E 00	0.1686246E 00	0.4417376E 01	-0.7000000E 00
0.2441614E-00	0.1867773E 00	0.4380450E 01	-0.8000000E 00
0.2936837E-00	-0.2114607E-00	0.4326717E 01	0.9000000E 00
0.3571605E 00	0.2454214E 00	0.4254327E 01	0.1000000E 01
0.4293358E 00	0.2963225E 00	0.4151450E 01	0.1100000E 01
0.5472729E 00	0.3754631E 00	0.3959333E 01	0.1200000E 01
0.7661277E 00	0.5150842E 00	0.3629508E 01	-0.1300000E 01
0.1366795E 01	0.9421117E 00	0.2492229E 01	-0.1400000E 01
0.2292277E 01	-0.2116817E 01	0.2068111E 01	-0.1450000E 01
0.5706333E 01	0.2200200E 01	0.	-0.1500000E 01
0.5765657E 02	0.4442534E 01	0.1125527E 02	0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.2057565E 01	0.1148535E 00	0.4513697E 01	0.1000000E-00
0.7217222E 01	0.1163496E 00	0.4519301E 01	0.4000000E-00
0.5455526E 01	0.1209793E 00	0.4527245E 01	0.5000000E 00
0.3128357E 01	0.1028637E-00	0.4537030E 01	0.6000000E 00
0.8321160E-02	0.1474551E 01	0.4547159E 01	0.7000000E 00
0.2036236E 01	0.4912842E 01	0.4557117E 01	0.8000000E 00
0.5177174E 01	0.4224673E 00	0.4566659E 01	0.9000000E 00
0.5474925E 01	0.7524466E 01	0.4575224E 01	0.1000000E 01
0.1249529E 02	0.5444231E 01	0.4582124E 01	0.1100000E 01
0.1661772E 00	0.5145207E 01	0.4587367E 01	0.1200000E 01
0.2172751E 00	0.5556214E 01	0.4593412E 01	0.1300000E 01
0.2587554E 00	0.4964427E 01	0.4597333E 01	0.1400000E 01
-0.3907216E 00	0.4419332E 01	0.4597332E 01	0.1500000E 01
0.3634513E 00	0.3925563E 01	0.4597726E 01	0.1600000E 01
0.4212434E 00	0.3421150E 01	0.4596163E 01	0.1700000E 01
0.4818109E 00	0.2941235E 01	0.4596556E 01	0.1800000E 01
-0.5456174E 00	0.2543256E 01	0.4593155E 01	0.1900000E 01
0.6126490E 00	0.2214632E 01	0.4589736E 01	0.2000000E 01
-0.6829223E 00	0.1846653E 01	0.4584320E 01	0.2100000E 01
0.7564455E 00	0.1585476E 01	0.4576750E 01	0.2200000E 01
-0.8332253E 00	0.1313301E 01	0.4569484E 01	0.2300000E 01
0.9132676E 00	0.1057723E 01	0.4561503E 01	0.2400000E 01
0.9965775E 00	-0.1652793E 00	0.4552427E 01	0.2500000E 01
0.1083157E 01	0.6671503E 00	0.4543476E 01	0.2600000E 01
0.1173018E 01	0.4684191E 00	0.4535523E 01	0.2700000E 01
0.1266152E 01	0.2982753E 00	0.4524172E 01	0.2800000E 01
0.1362568E 01	0.1513568E 02	0.4513496E 01	0.2900000E 01
0.1462260E 01	[illegible]	0.4503360E 01	0.3000000E 01

$\overline{T}_D$ = 0.4000000E 01 $\overline{W}$ = 0.1200000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.3047619E-00	0.5000000E-00	0.6000000E 01	0.
0.3382333E-00	0.5171194E 00	0.6346541E 01	0.1000000E-00
0.3674362E-00	0.5313411E 00	0.6025015E 01	-0.4000000E-00
0.4060618E-00	0.5529312E 00	0.6157753E 01	0.5000000E 00
0.4573558E-00	0.5771210E 00	0.6207764E 01	-0.6000000E 00
0.5251866E 00	0.6117709E 00	0.6299779E 01	-0.7000000E 00
0.6161156E 00	0.6578625E 00	0.6421032E 01	-0.8000000E 00
0.7416150E 00	0.7200702E 00	0.6583257E 01	-0.9000000E 00
0.9223974E 00	0.8065258E 00	0.6806526E 01	-0.1000000E 01
0.1210627E 01	0.9322311E 00	0.7128072E 01	-0.1100000E 01
0.1717772E 01	0.1128736E 01	0.7525362E 01	0.1200000E 01
0.2612454E 01	0.1473643E 01	0.8490456E 01	-0.1300000E 01
0.6150175E 01	0.2727720E 01	0.1036476E 02	-0.1400000E 01
0.1161909E 02	0.3973525E 01	0.1246723E 02	-0.1450000E 01
0.3124335E 02	0.5114123E 01	0.1751578E 02	0.1500000E 01
0.3544430E 03	0.1730057E 02	0.4694368E 02	0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.2725484E-00	0.4507341E-00	0.5956433E 01	0.1000000E-00
0.2479462E 00	0.4724306E-00	0.5924411E 01	0.4000000E-00
0.2187073E-00	0.4583282E-00	0.5885410E 01	0.5000000E 00
0.1547884E-00	0.4422945E-00	0.5846774E 01	0.6000000E 00
0.1464279E-00	0.4248576E-00	0.5791823E 01	0.7000000E 00
0.1047433E-00	0.4065206E-00	0.5739427E 01	0.8000000E 00
0.6083801E-01	0.3877510E-00	0.5685738E 01	0.9000000E 00
0.1202676E-01	0.3688696E 00	0.5631132E 01	0.1000000E 01
0.3578746E-01	0.3502394E-00	0.5576710E 01	0.1100000E 01
-0.9662387E-01	0.3323405E-00	0.5521406E 01	0.1200000E 01
0.1428632E 00	0.3145637E 00	0.5468387E 01	0.1300000E 01
-0.1988480E-00	0.2978053E-00	0.5416306E 01	0.1400000E 01
0.2572894E-00	0.2818728E-00	0.5365770E 01	0.1500000E 01
0.3180615E-00	0.2659705E 00	0.5316259E	0.1600000E 01
0.3811907E 00	0.2525451E 00	0.5267880E 01	0.1700000E 01
0.4458481E-00	0.2393166E-00	0.5224614E 01	0.1800000E 01
0.5150638E 00	0.2268341E 00	0.5161129E 01	0.1900000E 01
0.5859217E 00	0.2151539E 00	0.5139384E 01	0.2000000E 01
0.6595462E 00	0.2042334E 00	0.5097327E 01	0.2100000E 01
-0.7359830E 00	0.1940308E-00	0.5060891E 01	0.2200000E 01
0.8152973E 00	0.1844775E-00	0.5024038E 01	0.2300000E 01
0.8975444E 00	0.1755490E 00	0.4988607E 01	0.2400000E 01
0.9827743E 00	0.1672611E 00	0.4954618E 01	0.2500000E 01
0.1071029E 01	0.1594715E 00	0.4921973E 01	0.2600000E 01
0.1162344E 01	0.1521475E-00	0.4890606E 01	0.2700000E 01
-0.1256755E 01	0.1453499E-00	0.4860457E 01	0.2800000E 01
0.1354203E 01	0.1389456E 00	0.4831467E 01	0.2900000E 01
0.1454957E 01	0.1329351E 00	0.4803594E 01	0.3000000E 01

$\overline{T}_D$ = 0.4000000E 01 $\overline{W}$ = 0.1500000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1875172E 01	0.1125000E 01	0.7500000E 01	0.
0.1830097E 01	0.1165868E 01	0.7534920E 01	0.1000000E 00
0.1707556E 01	0.1199829E 01	0.7621971E 01	0.4000000E 00
0.1957723E 01	0.1246846E 01	0.7911560E 01	0.5000000E 00
0.2064355E 01	0.1308257E 01	0.7977333E 01	0.6000000E 00
0.2351131E 01	0.1392206E 01	0.8192181E 01	-0.7000000E 00
0.2755750E 01	0.1502522E 01	0.8461516E 01	0.8000000E 00
0.3342335E 01	0.1451692E 01	0.8817971E 01	0.9000000E 00
0.4262840E 01	0.1858975E 01	0.9354975E 01	0.1000000E 01
0.5732207E 01	0.2160905E 01	0.1011869E 02	0.1100000E 01
0.9494417E 01	0.2512435E 01	0.1129163E 02	-0.1200000E 01
0.1465121E 02	0.3467369E 01	0.1335180E 02	0.1300000E 01
0.3377257E 02	0.5775551E 01	0.1773354E 02	0.1400000E 01
0.6535526E 02	0.7311367E 01	0.2297516E 02	0.1450000E 01
0.7811107E 03	-0.1223625E 02	0.3577155E 02	0.1500000E 01
0.2031275E 04	0.4085307E 02	0.1256612E 03	0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1173067E 01	0.1007220E 01	0.7402172E 01	0.1000000E 00
0.1250314E 01	0.1059261E 01	0.7330521E 01	0.4000000E 00
0.1131702E 01	0.1025635E 01	0.7263521E 01	0.5000000E 00
0.1076120E 01	0.9814494E 00	0.7144518E 01	0.6000000E 00
0.9608442E 00	0.9459597E 00	0.7015490E 01	0.7000000E 00
0.8420841E 00	0.9071697E 00	0.6922484E 01	0.8000000E 00
0.7225497E 00	0.8577546E 00	0.6905217E 01	0.9000000E 00
0.6041800E 00	0.8110112E 00	0.6686969E 01	0.1000000E 01
0.4887915E 00	0.7689282E 00	0.6569597E 01	0.1100000E 01
0.3785637E 00	0.7260130E 00	0.6454541E 01	0.1200000E 01
0.2679412E 0	0.6848656E 00	0.6342135E 01	0.1300000E 01
0.1520519E 00	0.6485248E 00	0.6215227E 01	0.1400000E 01
0.4728511E 01	0.6078621E 00	0.6131213E 01	0.1500000E 01
0.5602117E 01	0.5725967E 00	0.6054152E 01	0.1600000E 01
0.1149793E 00	0.5194750E 00	0.5942917E 01	0.1700000E 01
0.1319130E 00	0.5086452E 00	0.5952[illegible] 01	0.1800000E 01
0.1242699E 02	0.4729507E 00	0.5762603E 01	0.1900000E 01
0.4172179E 0	0.4526918E 00	0.5690315E 01	0.2000000E 01
0.5112861E 00	0.4273369E 00	0.5615855E 01	0.2100000E 01
0.6266002E 00	0.4019189E 00	0.5554527E 01	0.2200000E 01
0.6496270E 00	0.3821299E 00	0.5478513E 01	0.2300000E 01
0.7941690E 00	0.3618555E 00	0.5415714E 01	0.2400000E 01
0.8910684E 00	0.3427985E 00	0.5356144E 01	0.2500000E 01
0.9891602E 00	0.3256135E-00	0.5300198E 01	0.2600000E 01
-0.1089478E 01	0.3090487E 00	0.5247068E 01	0.2700000E 01
-0.1191615E 01	0.2917825E-00	0.5196763E 01	0.2800000E 01
0.1295954E 01	0.2785424E-00	0.5148068E 01	0.2900000E 01
0.1402622E 01	0.2662635E-00	0.5103608E 01	0.3000000E 01

$\overline{T}_D$ = 0.4000000E 01 $\overline{W}$ = 0.1800000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.3519058E 01	0.1750000E 01	0.9000000E 01	0.
0.3707971E 01	0.1814603E 01	0.9163331E 01	-0.1000000E 00
0.4177119E 01	0.1468317E 01	0.9298931E 01	0.4000000E-00
0.4511637E 01	0.1942360E 01	0.9485587E 01	0.5000000E 00
0.5003377E 01	0.2041394E 01	0.9714932E 01	0.6000000E 00
0.5689500E 01	0.2172322E 01	0.1026458E 02	0.7000000E 00
0.6664305E 01	0.2347192E 01	0.1055220E 02	0.8000000E 00
0.8094858E 01	0.2583132E 01	0.1102715E 02	0.9000000E 00
0.1012607E 02	0.2911420E 01	0.1141142E 02	0.1000000E 01
0.1399195E 02	0.3389514E 01	0.1310112E 02	0.1100000E 01
0.2087127E 02	0.4137137E 01	0.1625768E 02	0.1200000E 01
0.3627353E 02	0.5551096E 01	0.1821235E 02	0.1300000E 01
0.8475497E 02	0.8323882E 01	0.2531442E 02	0.1400000E 01
0.1842208E 03	0.1155114E 02	0.3329364E 02	0.1450000E 01
0.4522950E 03	0.1235477E 02	0.5254713E 02	0.1500000E 01
0.5155950E 04	0.5470276E 02	0.1644316E 03	0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.3375276E 01	0.1689734E 01	0.8847908E 01	0.1000000E 00
0.3169407E 01	0.1646355E 01	0.8755681E 01	0.4000000E 00
0.2949741E 01	0.1597761E 01	0.8601765E 01	0.5000000E 00
0.2727294E 01	0.1553263E 01	0.8448252E 01	0.6000000E 00
0.2451660E 01	0.1487363E 01	0.8251140E 01	0.7000000E 00
0.2101959E 01	0.1398219E 01	0.8105140E 01	0.8000000E 00
0.1945767E 01	0.1327795E 01	0.7924496E 01	0.9000000E 00
0.1687902E 01	0.1257194E 01	0.7762806E 01	0.1000000E 01
0.1451770E 01	0.1197417E 01	0.7552785E 01	0.1100000E 01
0.1229103E 01	0.1110945E 01	0.7387278E 01	0.1200000E 01
0.1020775E 01	0.1036429E 01	0.7231518E 01	0.1300000E 01
0.8261455E 00	0.9927074E 00	0.7095294E 01	0.1400000E 01
0.6450968E 00	0.9318455E 00	0.6924465E 01	0.1500000E 01
0.4756713E 00	0.8763729E 00	0.6751165E 01	0.1600000E 01
0.3171310E 00	0.8261115E 00	0.6611755E 01	0.1700000E 01
0.1630555E 00	0.7773518E 00	0.6470531E 01	0.1800000E 01
0.2621660E 01	0.7321672E 00	0.6354876E 01	0.1900000E 01
0.1380111E 00	0.6899227E 00	0.6226881E 01	0.2000000E 01
0.2316223E 00	0.6563455E 00	0.6111571E 01	0.2100000E 01
0.3627121E 00	0.6118072E 00	0.6029172E 01	0.2200000E 01
0.4845458E 00	0.5797824E 00	0.5931057E 01	0.2300000E 01
0.6037408E 00	0.5481213E 00	0.5842031E 01	0.2400000E 01
0.7216535E 00	0.5187208E 00	0.5755070E 01	0.2500000E 01
0.8181538E 00	0.4913575E 00	0.5676423E 01	0.2600000E 01
0.9544158E 00	0.4659092E 00	0.5603572E 01	0.2700000E 01
0.1070735E 01	0.4422357E 00	0.5533079E 01	0.2800000E 01
0.1187584E 01	0.4761392E 00	0.5466529E 01	0.2900000E 01
0.1305202E 01	0.3995570E 00	0.5406312E 01	0.3000000E 01

TABLE 1.5-1 (Cont'd)

VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = 0.40000000E 01 $\overline{W}$ = 0.21000000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.67333333E 01	0.23750000E 01	0.10500000E 02	0.
0.72618571E 01	0.24633345E 01	0.10721170E 02	-0.30000000E 00
0.77201119E 01	0.25368005E 01	0.10920559E 02	-0.40000000E-00
0.83685771E 01	0.26380578E 01	0.11115251E 02	-0.50000000E 00
0.92738171E 01	0.27735331E 01	0.11528470E 02	-0.60000000E 00
0.10540333E 02	0.29510380E 01	0.11946770E 02	-0.70000000E 00
0.12344761E 02	0.31718642E 01	0.12562740E 02	-0.80000000E 00
0.15002172E 02	0.35146863E 01	0.13346840E 02	-0.90000000E 00
0.19117261E 02	0.39630847E 01	0.14463470E 02	-0.10000000E 01
0.25995881E 02	0.46181320E 01	0.16282940E 02	-0.11000000E 01
0.33050280E 02	0.56411340E 01	0.19521530E 02	-0.12000000E 01
0.67676391E 02	0.76398231E 01	0.23371530E 02	0.13000000E 01
0.15046604E 03	0.11372201E 02	0.32233150E 02	0.14000000E 01
0.30605561E 03	0.15792291E 02	0.43704401E 02	0.14500000E 01
0.85152751E 03	0.28472492E 02	0.70351110E 02	-0.15000000E 01
0.96624701E 04	0.86550851E 02	0.22326240E 03	-0.15500000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.62772831E 01	0.22292451E 01	0.10291641E 02	[illegible]
0.59152461E 01	[illegible]	[illegible]	0.40000000E-00
0.55166211E 01	0.21602431E 01	[illegible]	[illegible]
0.50782951E 01	0.20772591E 01	[illegible]	[illegible]
0.46183131E 01	[illegible]	[illegible]	[illegible]
0.41563661E 01	[illegible]	[illegible]	[illegible]
0.35225511E 01	0.17974051E 01	[illegible]	[illegible]
0.32633911E 01	[illegible]	[illegible]	[illegible]
0.29521591E 01	[illegible]	[illegible]	[illegible]
0.24622361E 01	[illegible]	[illegible]	[illegible]
0.21159851E 01	[illegible]	[illegible]	[illegible]
0.17721531E 01	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
0.12231621E 01	[illegible]	[illegible]	[illegible]
0.97581451E 00	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = 0.40000000E 01 $\overline{W}$ = 0.24000000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.10819051E 02	0.50000000E 01	0.12000000E 02	0.
0.11662301E 02	0.51120851E 01	0.12280091E 02	-0.30000000E-00
0.12372571E 02	0.52052241E 01	0.12512851E 02	-0.40000000E-00
0.13628451E 02	0.53337451E 01	0.12833441E 02	-0.50000000E 00
0.14875891E 02	0.55056601E 01	0.13262041E 02	-0.60000000E 00
0.16903581E 02	0.57334551E 01	0.13829391E 02	-0.70000000E 00
0.17776171E 02	0.60365911E 01	0.14563361E 02	-0.80000000E 00
0.24061211E 02	0.64461741E 01	0.15601421E 02	-0.90000000E 00
0.30677481E 02	0.50163141E 01	0.17016311E 02	-0.10000000E 01
0.41738021E 02	0.58467451E 01	0.19074561E 02	-0.11000000E 01
0.62431461E 02	0.71455401E 01	0.22289501E 02	-0.12000000E 01
0.10886781E 03	0.94285491E 01	0.27934251E 02	-0.13000000E 01
0.25515391E 03	0.14422341E 02	0.40263871E 02	-0.14000000E 01
0.49301981E 03	0.20032891E 02	0.54118721E 02	-0.14500000E 01
0.13862571E 04	0.33590621E 02	0.87570891E 02	-0.15000000E 01
0.35572831E 05	0.11240291E 03	0.29204331E 03	0.15500000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.10042271E 02	0.24957941E 01	0.11739381E 02	0.30000000E 00
0.95377491E 01	0.28196751E 01	0.11744951E 02	0.40000000E-00
0.88345591E 01	0.27275541E 01	0.11314111E 02	0.50000000E 00
0.81492142E 01	0.26229141E 01	0.11055751E 02	0.60000000E 00
0.74533321E 01	0.25092621E 01	0.10770461E 02	0.70000000E 00
0.67231101E 01	0.23899171E 01	0.10477951E 02	0.80000000E 00
0.60314609E 01	0.22267931E 01	[illegible]	0.90000000E 00
0.53305521E 01	0.21455201E 01	0.98544501E 01	0.10000000E 01
0.46899121E 01	0.20242241E 01	0.95497571E 01	0.11000000E 01
0.43957211E 01	0.19770191E 01	0.92527591E 01	0.12000000E 01
0.35551981E 01	0.17256751E 01	0.89651221E 01	0.13000000E 01
0.30487101E 01	0.16876391E 01	0.86227871E 01	0.14000000E 01
[illegible]	0.15855111E 01	0.84712251E 01	0.15000000E 01
0.22061021E 01	0.14893251E 01	0.81817911E 01	0.16000000E 01
[illegible]	[illegible]	0.77256291E 01	0.17000000E 01
0.15039781E 01	[illegible]	[illegible]	0.18000000E 01
[illegible]	0.12375001E 01	[illegible]	0.19000000E 01
0.93579611E 00	0.11865951E 01	[illegible]	0.20000000E 01
[illegible]	[illegible]	0.71635311E 01	0.21000000E 01
[illegible]	0.10335841E 01	[illegible]	0.22000000E 01
[illegible]	[illegible]	[illegible]	0.23000000E 01
[illegible]	[illegible]	[illegible]	0.24000000E 01
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.26000000E 01
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.28000000E 01
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = [illegible] $\overline{W}$ = [illegible]

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = [illegible] $\overline{W}$ = [illegible]

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-1 (Cont'd)

VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = 0.8000000E 01 $\overline{W}$ = 0.6000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1047619E 02	-0.2750000E 01	0.3000000E 01	0.
0.1127887E 02	-0.2858214E 01	0.2742761E 01	-0.3000000E-00
0.1196819E 02	-0.2948245E 01	0.2528281E 01	-0.4000000E-00
0.1295000E 02	-0.3072389E 01	0.2231903E 01	-0.5000000E 00
0.1432195E 02	-0.3238578E 01	0.1834112E 01	-0.6000000E 00
0.1624307E 02	-0.3458912E 01	0.1305133E 01	-0.7000000E 00
0.1898224E 02	-0.3752233E 01	0.5985708E 00	-0.8000000E 00
0.2301967E 02	-0.4149045E 01	-0.3607264E-00	-0.9000000E 00
0.2928067E 02	-0.4701631E 01	-0.1701631E 01	-0.1000000E 01
0.3974405E 02	-0.5507099E 01	-0.3663590E 01	-0.1100000E 01
0.5931515E 02	-0.6767729E 01	-0.6745530E 01	-0.1200000E 01
0.1032244E 03	-0.8985075E 01	-0.1218478E 02	-0.1300000E 01
0.2415324E 03	-0.1383595E 02	-0.2411846E 02	-0.1400000E 01
0.4664154E 03	-0.1929145E 02	-0.3756026E 02	-0.1450000E 01
0.1312776E 04	-0.3247249E 02	-0.7006311E 02	-0.1500000E 01
0.1472285E 05	-0.1090794E 03	-0.2591113E 03	-0.1550000E 01
TENSILE END LOADS			
0.9756793E 01	-0.2549436E 01	0.3238449E 01	0.3000000E-00
0.9242913E 01	-0.2576005E 01	0.3412161E 01	0.4000000E-00
0.8640794E 01	-0.2487183E 01	0.3621796E 01	0.5000000E 00
0.7979397E 01	-0.2386341E 01	0.385[illegible]E 01	0.6000000E 00
0.7207904E 01	-0.2276892E 01	0.4115677E 01	0.7000000E 00
0.6591697E 01	-0.2162055E 01	0.4383714E 01	0.8000000E 00
0.5910830E 01	-0.2044693E 01	0.4556201E 01	0.9000000E 00
0.5259896E 01	-0.1927240E 01	0.4927240E 01	0.1000000E 01
0.4648419E 01	-0.1811654E 01	0.5192101E 01	0.1100000E 01
0.4081649E 01	-0.1699434E 01	0.5447185E 01	0.1200000E 01
0.3567444E 01	-0.1591669E 01	0.5689921E 01	0.1300000E 01
0.3087231E 01	-0.1489091E 01	0.5918618E 01	0.1400000E 01
0.2656740E 01	-0.1392137E 01	0.6132309E 01	0.1500000E 01
0.2266698E 01	-0.1301016E 01	0.6330600E 01	0.1600000E 01
0.1913292E 01	-0.1215756E 01	0.6513536E 01	0.1700000E 01
0.1592528E 01	-0.1136259E 01	0.6681470E 01	0.1800000E 01
0.1300487E 01	-0.1062331E 01	0.6835014E 01	0.1900000E 01
0.1033370E 01	-0.9937197E 00	0.6974879E 01	0.2000000E 01
0.7877890E 00	-0.9301352E 00	0.7101896E 01	0.2100000E 01
0.5606001E 00	-0.8712674E 00	0.7216934E 01	0.2200000E 01
0.3490164E 00	-0.8167999E 00	0.7320071E 01	0.2300000E 01
0.1505763E-00	-0.7664191E 00	0.7413457E 01	0.2400000E 01
-0.3687769E-01	-0.7198211E 00	0.7498882E 01	0.2500000E 01
-0.2152253E-00	-0.6767150E 00	0.7574591E 01	0.2600000E 01
-0.3860975E-00	-0.6368262E 00	0.7642463E 01	0.2700000E 01
-0.5509055E 00	-0.5998974E 00	0.7703196E 01	0.2800000E 01
-0.7108662E 00	-0.5656694E 00	0.7757448E 01	0.2900000E 01
-0.8670369E 00	-0.5339805E 00	0.7805825E 01	0.3000000E 01

$\overline{T}_D$ = 0.8000000E 01 $\overline{W}$ = 0.9000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.6504762E 01	-0.2125000E 01	0.4500000E 01	0.
0.7001376E 01	-0.2209472E 01	0.4501147E 01	-0.3000000E-00
0.7420044E 01	-0.2279758E 01	0.4135239E 01	-0.4000000E-00
0.8034526E 01	-0.2376680E 01	0.3905833E 01	-0.5000000E 00
0.8880792E 01	-0.2506441E 01	0.3597681E 01	-0.6000000E 00
0.1006408E 02	-0.2678496E 01	0.3187557E 01	-0.7000000E 00
0.1174865E 02	-0.2907573E 01	0.2639153E 01	-0.8000000E 00
0.1422800E 02	-0.3217571E 01	0.1893314E 01	-0.9000000E 00
0.1806738E 02	-0.3649184E 01	0.8508357E 00	-0.1000000E 01
0.2547583E 02	-0.4278406E 01	-0.6767675E 00	-0.1100000E 01
0.3645038E 02	-0.5265570E 01	-0.3070481E 01	-0.1200000E 01
0.6329644E 02	-0.6996343E 01	-0.7323920E 01	-0.1300000E 01
0.1478190E 03	-0.1078162E [illegible]	-0.1664573E 02	-0.1400000E 01
0.2052270E 03	-0.1505747E [illegible]	-0.2714616E 02	-0.1450000E 01
0.8023408E 03	-0.2535437E 02	-0.5254733E 02	-0.1500000E 01
0.9995532E 04	-0.8526933E 02	-0.2003115E 03	-0.1550000E 01
TENSILE END LOADS			
0.6061738E 01	-0.2046505E 01	0.4604185E 01	0.3000000E [illegible]
0.5739357E 01	-0.1989194E 01	0.4918271E 01	0.4000000E 00
0.5365041E 01	-0.1919878E 01	0.4979969E 01	0.5000000E 00
0.4953090E 01	-0.1841188E 01	0.5182027E 01	0.6000000E 00
0.4521148E 01	-0.1755791E 01	0.5360337E 01	0.7000000E 00
0.4084907E 01	-0.1666204E 01	0.5566370E 01	0.8000000E 00
0.3656625E 01	-0.1574667E 01	0.5775483E 01	0.9000000E 00
0.3245209E 01	-0.1483017E 01	0.5983077E 01	0.1000000E 01
0.2856599E 01	-0.1392965E 01	0.6185487E 01	0.1100000E 01
0.2493710E 01	-0.1305502E 01	0.6379922E 01	0.1200000E 01
0.2157986E 01	0.1221536E 01	0.6564397E 01	0.1300000E 01
0.1848978E 01	-0.1141646E 01	0.6737615E 01	0.1400000E 01
0.1565323E 01	-0.1066154E 01	0.6898848E 01	0.1500000E 01
0.1305025E 01	-0.9952397E 00	0.7047814E 01	0.1600000E 01
0.1065764E 01	-0.9289181E 00	0.7164575E 01	0.1700000E 01
0.8451109E 00	-0.8671100E 00	0.7309436E 01	0.1800000E 01
0.6406669E 00	-0.8096[illegible]E 00	0.7422980E 01	0.1900000E 01
0.4501575E-00	-0.7563[illegible]E 00	0.7525527E 01	0.2000000E 01
0.2714836E 00	-0.7070346E 00	0.7618023E 01	0.2100000E 01
0.1027442E-00	-0.6613992E 00	0.7701075E 01	0.2200000E 01
0.5775594E-01	0.6191676E 00	0.7775395E 01	0.2300000E 01
-0.2135143E-00	0.5801530E 00	0.7841681E 01	0.2400000E 01
0.3598429E 00	0.5440972E 00	0.7900407E 01	0.2500000E 01
-0.5038849E 00	-0.5107770E 00	0.79[illegible]E 01	0.2600000E 01
-0.6446319E 00	-0.4799617E-00	0.7969921E 01	0.2700000E 01
-0.7829410E 00	0.4514046E-00	0.8059482E 01	0.2800000E 01
0.9135554E 00	-0.4250926E-00	0.8075032E 01	0.2900000E 01
0.1055112E 01	-0.4009721E-00	0.8104049E 01	0.3000000E 01

$\overline{T}_D$ = 0.8000000E 01 $\overline{W}$ = 0.1200000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.3504762E 01	0.1500000E 01	0.6000000E 01	0.
0.377[illegible] 01	-0.1560730E 01	0.5859534E 01	0.3000000E [illegible]
0.3990758E [illegible]	-0.1611269E 01	0.5742197E 01	0.4000000E 00
0.4321840E 01	0.1680912E 01	[illegible] 01	0.5000000E 00
0.4771266E 01	0.1774305E 01	[illegible] 01	0.6000000E 00
0.5397510E 01	0.1898081E 01	[illegible] 01	0.7000000E 00
0.6286044E 01	0.2082914E 01	0.4679735E 01	0.8000000E 00
0.7589130E 01	-0.2285498E 01	0.4140354E 01	0.9000000E 00
0.9600414E 01	0.2598737E 01	0.3403293E 01	0.1000000E 01
0.1294780E 02	-0.3049872E 01	0.2309555E 01	0.1100000E 01
0.1918779E 02	-0.3759120E 01	0.5865682E 00	0.1200000E 01
0.3315302E 02	-0.5027621E 01	-0.2462080E 01	0.1300000E 01
0.7707314E 02	0.7739284E 01	0.9169001E 01	0.1400000E 01
0.1684480E 03	0.1083190E 02	[illegible] 02	0.1450000E 01
0.4170176E 03	0.1923322E 02	0.3503155E 02	0.1500000E 01
0.4672052E 04	0.6159922E 02	0.1415116E 03	0.1550000E 01
TENSILE END LOADS			
0.3271841E 01	0.1445575E 01	0.6127922E 01	[illegible]
0.3092300E 01	-0.1422301E 01	0.6224381E 01	[illegible]
0.2590195E 01	-0.1352570E 01	0.6338142E 01	[illegible]
0.2686016E 01	0.1299235E 01	0.6460571E 01	[illegible]
0.2412825E 01	0.1234590E 01	0.6604998E 01	[illegible]
0.2190355E 01	0.1170355E 01	0.6749027E 01	0.8000000E [illegible]
0.1953368E 01	0.1106461E 01	0.6874159E 01	0.9000000E [illegible]
0.1722492E 01	0.1038915E 01	0.7034715E 01	0.1000000E 01
0.1501977E 01	0.9742702E 00	0.7117534E 01	0.1100000E 01
0.1291205E 01	-0.9115691E 00	0.7312659E 01	0.1200000E 01
0.1097877E 01	0.8514018E 00	0.7435872E 01	0.1300000E 01
0.9125188E 00	0.7941897E 00	0.7554612E 01	0.1400000E 01
0.7397461E 00	0.7421716E 00	0.7645380E 01	0.1500000E 01
0.5776278E 00	0.6896435E 00	0.7765026E 01	0.1600000E 01
0.4263775E 00	0.6420785E 00	0.7055410E 01	0.1700000E 01
0.2793373E 00	0.5979014E 00	0.7857135E 01	0.1800000E 01
0.1410776E 00	0.5569977E 00	0.8[illegible] 01	0.1900000E 01
0.8475675E [illegible]	0.5190412E 00	0.8073175E 01	0.2000000E 01
0.1176781E-00	0.4841391E 00	0.8141482E 01	0.2100000E 01
0.2442714E-00	0.4534111E 00	0.8185217E 01	0.2200000E 01
0.3641044E-00	[illegible]	0.8229922E 01	0.2300000E 01
0.4861521E 00	0.3958840E 00	0.8268788E 01	0.2400000E 01
-0.6049134E 00	0.3683733E 00	0.8312351E 01	0.2500000E 01
0.7250087E [illegible]	-0.3440292E-00	0.8331044E 01	0.2600000E 01
0.8409713E 00	-0.3230273E 00	0.8355179E 01	0.2700000E 01
-0.9592374E 00	[illegible]	0.8375264E 01	0.2800000E 01
0.1078155E 01	-0.2844959E 00	0.8392310E 01	0.2900000E 01
0.1198143E 01	0.2673636E 00	0.8409827E 01	0.3000000E 01

$\overline{T}_D$ = 0.8000000E 01 $\overline{W}$ = 0.1500000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1478190E [illegible]	-0.8750000E 00	0.7500000E 01	0.
[illegible]	-0.9119871E 00	0.7411771E 01	0.1000000E 00
0.1580168E 01	-0.9627810E 00	0.7369135E 01	0.4000000E 00
0.1811991E 01	-0.9852411E 00	0.7254684E 01	0.5000000E 00
0.1899353E 01	0.1042169E 01	0.7124082E 01	0.6000000E 00
0.2249436E 01	0.1111784E 01	0.6952144E 01	0.7000000E 00
0.2596339E 01	0.1218254E 01	0.6723911E 01	0.8000000E 00
0.3101038E 01	0.1355443E 01	0.6402809E 01	0.9000000E 00
0.3879766E 01	0.1544290E 01	0.5945710E 01	0.1000000E 01
0.5159769E 01	0.1821254E 01	0.5286277E 01	0.1100000E 01
0.7527352E 01	0.2255121E [illegible]	0.4252618E [illegible]	0.1200000E 01
0.1295413E 02	0.3215895E 01	0.2143368E 01	0.1300000E 01
0.2229685E 02	0.4682955E 01	0.1494271E 01	0.1400000E 01
0.5603102E 02	0.6572129E 01	0.4117[illegible] 01	0.1450000E 01
[illegible]	0.3711012E 02	0.3151570E 02	0.1500000E 01
[illegible]	0.1754811E 02	0.9771117E 02	-0.1550000E 01
TENSILE END LOADS			
0.1386145E [illegible]	0.3460444E [illegible]	[illegible]	0.3000000E [illegible]
0.1302207E 01	0.8179720E 00	0.7810491E 01	0.4200000E [illegible]
0.1214755E [illegible]	0.7052431E [illegible]	0.7678314E [illegible]	[illegible]
0.1109990E [illegible]	0.7508765E 00	[illegible]	0.6000000E [illegible]
0.1014536E 01	0.7155061E 00	0.7866558E [illegible]	0.7000000E 00
0.9004160E [illegible]	0.6745578E 00	0.7951896E 01	0.8000000E [illegible]
0.8231592E [illegible]	-0.6344154E [illegible]	0.8214319E 01	0.9000000E 00
[illegible]	0.5447512E 00	0.8094752E 01	0.1000000E 01
0.5588467E [illegible]	-0.5555474E 00	0.8172281E [illegible]	0.1100000E 01
0.4801287E-00	0.5176448E 00	0.7245117E 01	0.1200000E 01
[illegible]	-0.4841710E 00	0.9318194E [illegible]	0.1300000E 01
0.2778514E 00	[illegible]	0.8501962E 01	0.1400000E 01
0.1830097E 00	0.4141948E 00	0.8411925E 01	0.1500000E 01
0.8391303E [illegible]	0.3936014E 00	0.8402134E 01	0.1600000E 01
0.1308650E [illegible]	0.3532415E [illegible]	0.8526684E [illegible]	0.1700000E 01
[illegible]	0.3298121E-00	0.8565353E 01	0.1800000E 01
0.1991012E 00	0.3243312E 00	0.8590655E 01	0.1900000E 01
0.2918255E 00	0.2980254E-00	0.8626[illegible]	0.2000000E 01
0.3957555E 00	0.2638556E 00	0.8651931E 01	[illegible]
0.4804470E 00	[illegible]	0.8669350E 01	0.2200000E 01
0.5742149E 00	0.2254225E 00	0.8844444E 01	0.2300000E 01
0.6751177E [illegible]	0.2076274E-00	0.8695394E 01	0.2400000E 01
0.7720592E [illegible]	[illegible]	0.8124259E 01	0.2500000E 01
0.8723902E 00	0.1788843E 00	0.8739243E 01	0.2600000E 01
0.9751155E [illegible]	0.1662124E-00	0.8771847E 01	0.2700000E 01
-0.1017972E [illegible]	0.1545998E-00	0.8712094E 01	0.2800000E 01
[illegible]	0.1437894E 00	0.8753191E 01	0.2900000E 01
0.1294130E [illegible]	-0.1340552E 00	0.8706497E 01	0.3000000E 01

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = 0.8000000E 01 $\overline{W}$ = 0.1800000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.4190478E-00	-0.2500000E-00	0.9000000E 01	0.
0.4467045E-00	-0.2652456E-00	0.8976308E 01	0.3000000E-00
0.4725374E-00	-0.2742944E-00	0.8956113E 01	-0.4000000E-00
0.5049540E 00	-0.2895546E-00	0.8927611E 01	-0.5000000E 00
0.5470643E 00	-0.3100314E-00	0.8888389E 01	-0.6000000E 00
0.6017655E 00	-0.3372493E-00	0.8834748E 01	-0.7000000E 00
0.6734456E 00	-0.3735945E-00	0.8760900E 01	-0.8000000E 00
0.7697329E 00	-0.4229214E-00	0.8657434E 01	-0.9000000E 00
0.9054419E 00	-0.4918427E-00	0.8508157E 01	-0.1000000E 01
0.1112343E 01	-0.5926449E 00	0.8282900E 01	-0.1100000E 01
0.1469091E 01	-0.7509263E 00	0.7918666E 01	-0.1200000E
0.2219791E 01	-0.1050168E 01	0.7259016E 01	-0.1300000E 01
0.4487131E 01	-0.1642623E 01	0.5780450E 01	-0.1400000E 01
0.8117658E 01	-0.2332356E 01	0.4096222E 01	-0.1450000E 01
0.2170833E 02	-0.4000000E 01	-0.	-0.1500000E 01
0.2366250E 03	-0.1369906E 02	-0.2391193E 02	-0.1550000E 01
TENSILE END LOADS			
0.4073018E-00	-0.2377131E-00	0.9021394E 01	0.3000000E-00
0.3687089E-00	-0.2287608E-00	0.9036602E 01	0.4000000E-00
0.3432210E-00	-0.2179565E-00	0.9054407E 01	0.5000000E 00
0.3331934E-00	-0.2057213E-00	0.9074060E 01	0.6000000E 00
0.2782846E-00	-0.1924870E-00	0.9094318E 01	0.7000000E 00
0.2397508E-00	-0.1786566E-00	0.9114340E 01	0.8000000E 00
0.1979049E-00	-0.1645096E-00	0.9133317E 01	0.9000000E 00
0.1529630E-00	-0.1505889E 00	0.9150589E 01	0.1000000E 01
0.1051235E-00	-0.1358986E 00	0.9165647E 01	0.1100000E 01
0.5448821E-01	0.1257064E-00	0.9178134E 01	0.1200000E 01
0.1029854E-02	0.1111392E 00	0.9187023E 01	0.1300000E 01
0.5502153E-01	-0.9928854E-01	0.9194605E 01	0.1400000E 01
-0.1138863E-00	-0.8820597E-01	0.9178463E 01	0.1500000E 01
0.1755252E-00	0.7791121E-01	0.9129453E 01	0.1600000E 01
-0.2399737E-00	0.6840312E-01	0.9197695E 01	0.1700000E 01
-0.3072758E [illegible]	0.5966410E [illegible]	[illegible]	0.1800000E 01
-0.3776690E [illegible]	0.5166472E-01	0.9186509E 01	0.1900000E 01
-0.4505960E-00	[illegible]	[illegible]	0.2000000E 01
-0.5266891E 00	-0.3773266E 01	0.9166401E 01	[illegible]
0.6357822E 00	[illegible]	[illegible]	[illegible]
0.6079014E 00	0.2627091E 01	0.9138968E 01	[illegible]
0.7730706E 00	0.2133464E [illegible]	[illegible]	[illegible]
-0.8613099E 00	0.1692559E 01	0.9105745E 01	[illegible]
-0.7526153E 00	0.1298130E 01	[illegible]	[illegible]
0.1057185E 03	[illegible]	[illegible]	[illegible]
0.1144607E 01	[illegible]	[illegible]	[illegible]
0.1245273E 01	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = 0.8000000E 01 $\overline{W}$ = 0.2100000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.3333333E-00	0.3749999E-00	0.1050000E 02	0.
0.3543132E-00	0.3854971E-00	0.1053469E 02	-0.3000000E-00
0.3757671E-00	0.3941946E-00	0.1056307E 02	-0.4000000E-00
0.4006755E-00	0.4061537E-00	0.1060154E 02	-0.5000000E 00
0.4323928E-00	0.4221053E-00	0.1065196E 02	-0.6000000E 00
0.4725427E-00	0.4431660E-00	0.1071715E 02	0.7000000E 00
0.5234972E 00	0.4710655E-00	0.1080140E 02	-0.8000000E 00
0.5892016E 00	0.5086095E 00	0.1091197E 02	-0.9000000E 00
0.6774394E 00	0.5606045E 00	0.1106060E 02	-0.1000000E 01
0.8049149E 00	0.6359686E 00	0.1126752E 02	-0.1100000E 01
0.1013000E 01	0.7532745E 00	0.1158473E 02	-0.1200000E 01
0.1429991E 01	0.9585587E 00	0.1211996E 02	-0.1300000E 01
0.2645931E 01	0.1405708E 01	0.1325519E 02	-0.1400000E 01
0.4566821E 01	0.1907417E 01	0.1451034E 02	-0.1450000E 01
0.1172220E 02	0.3118123E 01	0.1751578E 02	-0.1500000E 01
0.1246775E 03	0.1015106E 02	0.3488791E 02	-0.1550000E 01
TENSILE END LOADS			
0.1326256E-00	0.3652174E-00	0.1046713E 02	0.3000000E 00
0.2919475E-00	0.3580535E 00	0.1044271E 02	0.4000000E 00
0.2710470E-00	0.3493500E-00	0.1041266E 02	0.5000000E 00
0.2462506E-00	0.3394335E 00	0.1037780E 02	0.6000000E 00
0.2164525E 00	0.3286140E-00	0.1033898E 02	0.7000000E 00
0.1830938E-00	0.3171923E 00	0.1029700E 02	0.8000000E 00
0.1462889E-00	0.3054361E 00	0.1025760E 02	0.9000000E 00
0.1061509E 00	0.2935740E 00	0.1020543E 02	0.1000000E 01
0.6270859E 01	0.2817901E 00	0.1015903E 02	0.1100000E 01
0.1628035E-01	0.2702284E 00	0.1011087E 02	0.1200000E 01
-0.3336259E 01	0.2589946E 00	0.1006230E 02	0.1300000E 01
0.8610371E 01	0.2481620E 00	0.1001360E 02	0.1400000E 01
-0.1419423E-00	0.2377762E 00	0.9965032E 01	0.1500000E 01
-0.2008846E-00	[illegible]	[illegible]	0.1600000E 01
0.2629378E 00	0.2184351E 00	0.9468722E 01	0.1700000E 01
-0.3281161E 00	0.2094845E 00	0.9821270E 01	[illegible]
0.3764203E 00	0.2210318E 00	0.9774368E 01	[illegible]
0.4678858E 00	0.1929697E 00	0.9728120E 01	[illegible]
0.5424989E 00	0.1853680E 00	0.9682527E 01	[illegible]
0.6202777E 00	0.1781233E 00	0.9637541E 01	[illegible]
0.7212260E 00	0.1711362E 00	0.9593472E 01	[illegible]
0.7855509E 00	0.1644911E 00	0.9550308E 01	[illegible]
0.8722555E 00	0.1581798E-00	0.9507511E 01	[illegible]
0.9631444E 00	0.1513300E 00	0.9465723E 01	[illegible]
0.1256813E 01	0.1467496E 00	0.9424754E 01	[illegible]
0.1155368E 01	0.1422570E 00	0.9384627E 01	[illegible]
0.1254731E 01	0.1372986E 00	0.9345335E 01	[illegible]
0.1356972E 01	0.1325617E 00	[illegible]	[illegible]

$\overline{T}_D$ = 0.8000000E 01 $\overline{W}$ = [illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = [illegible] $\overline{W}$ = [illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = 0.1200000E 02 $\overline{W}$ = 0.3000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.3888571E 02	0.5375000E 01	0.1500000E 01	0.
0.4185295E 02	-0.5584805E 01	0.9973676E 00	-0.3000000E-00
0.4440331E 02	-0.5759344E 01	0.5705047E 00	-0.4000000E-00
0.4804167E 02	-0.6000000E 01	-0.	-0.5000000E 00
0.5313352E 02	-0.6322140E 01	-0.7759704E 00	-0.6000000E 00
0.6027531E 02	-0.6749199E 01	-0.1807107E 01	-0.7000000E 00
0.7047550E 02	-0.7317669E 01	-0.3183308E 01	-0.8000000E 00
0.8553522E 02	-0.8086629E 01	-0.5056170E 01	-0.9000000E 00
0.1089252E 03	0.9157341E 01	-0.7657342E 01	-0.1000000E 01
0.1480674E 03	-0.1071788E 02	-0.1146963E 02	-0.1100000E 01
0.2213610E 03	0.1315999E 02	-0.1745039E 02	0.1200000E 01
0.3859326E 03	-0.1745507E 02	0.2799906E 02	-0.1300000E 01
0.9045676E 03	-0.2685058E 02	-0.5112715E 02	-0.1400000E 01
0.1747995E 04	-0.3741671E 02	-0.7716964E 02	0.1450000E 01
0.4922478E 04	-0.6294499E 02	-0.1401262E 03	0.1500000E 01
0.5522135E 05	-0.2113691E 03	-0.5062667E 03	-0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.3622474E 02	0.5180015E 01	0.1266201E 01	0.3000000E 00
0.3433692E 02	-0.5037630E 01	0.2306021E 01	0.4000000E 00
0.3212429E 02	0.4865387E 01	0.2716347E 01	0.5000000E 00
0.2969702E 02	-0.4669822E 01	0.3181136E 01	0.6000000E 00
0.2716695E 02	-0.4457540E 01	0.3684195E 01	0.7000000E 00
0.2462888E 02	-0.4234777E 01	0.4212257E 01	0.8000000E 00
0.2215801E 02	0.4007091E 01	0.4745743E 01	0.9000000E 00
0.1980404E 02	-0.3779186E 01	0.5279196E 01	0.1000000E 01
0.1761768E 02	-0.3554058E 01	0.5801378E 01	0.1100000E 01
0.1560354E 02	0.3337016E 01	0.6305303E 01	0.1200000E 01
0.1377361E 02	-0.3127770E 01	0.6795930E 01	0.1300000E 01
0.1212563E 02	-0.2921537E 01	0.7239931E 01	0.1400000E 01
0.1065111E 02	0.2740172E 01	0.7635186E 01	0.1500000E 01
0.9337699E 01	0.2563070E 01	0.8061474E 01	0.1600000E 01
0.8171068E 01	-0.2397311E 01	0.8420229E 01	0.1700000E 01
0.7136196E 01	-0.2242585E 01	0.8766103E 01	0.1800000E 01
0.6218269E 01	0.2098829E 01	0.9076277E 01	0.1900000E 01
0.5403236E 01	0.1965255E 01	0.9361322E 01	0.2000000E 01
0.4678125E 01	0.1841404E 01	0.9620592E 01	0.2100000E 01
0.4031192E 01	0.1726677E 01	0.9857118E 01	0.2200000E 01
0.3451954E 01	-0.1620465E 01	0.1007223E 02	0.2300000E 01
0.2931157E 01	-0.1522161E 01	0.1026765E 02	0.2400000E 01
0.2460677E 01	0.1431117E 01	0.1044487E 02	0.2500000E 01
0.2033438E 01	0.1346954E 01	0.1060544E 02	0.2600000E 01
0.1843317E 01	-0.1268964E 01	0.1075079E 02	0.2700000E 01
0.1284997E 01	-0.1196[illegible]E 01	0.1088222E 02	0.2800000E 01
0.9538918E 00	-0.1129724E 01	0.1100101E 02	0.2900000E 01
0.6460457E 00	-0.1067588E 01	0.1110329E 02	0.3000000E 01

$\overline{T}_D$ = 0.1200000E 02 $\overline{W}$ = 0.6000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.3074286E 02	0.4750000E 01	0.5000000E 01	0.
0.3308267E 02	-0.4936063E 01	0.2555754E 01	-0.3000000E-00
0.3509379E 02	0.5090856E 01	0.2185463E 01	-0.4000000E 00
0.3796214E 02	0.5304291E 01	0.1673227E 01	-0.5000000E 00
0.4127564E 02	-0.5590003E 01	0.9975788E 00	[illegible]
0.4750384E 02	-0.5968783E 01	[illegible]E-01	[illegible]
0.5564065E 02	0.6473009E 01	-0.1142726E 01	[illegible]
0.6750397E 02	0.7155029E 01	-0.2725630E 01	[illegible]
0.8592602E 02	0.8104894E 01	-0.5104494E 01	[illegible]
0.1167496E 03	-0.9489262E 01	0.8482007E 01	[illegible]
[illegible].1744590E 03	0.1165579E 02	0.1378434E 02	[illegible]
0.3040255E 03	-0.1546636E 02	0.2313311E 02	[illegible]
0.7125195E 03	[illegible].3802254E 02	0.4365742E 02	[illegible]
[illegible].1376223E 04	0.3317694E 02	[illegible].6675452E 02	[illegible]
[illegible].3475322E 04	-0.5582686E 02	[illegible].1226104E 03	[illegible]
[illegible].4347171E 05	0.1876992E 03	0.4478664E 03	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.2864555E 02	-0.4572094E 01	0.3611938E 01	[illegible]
0.2715607E 02	0.4450819E 01	0.3712131E 01	[illegible]
0.2544863E 02	0.4298095E 01	0.4074520E 01	[illegible]
[illegible].2367291E [illegible]	0.4124667E 01	0.4486980E 01	[illegible]
[illegible].2169529E [illegible]	0.3936439E 01	0.4925855E 01	[illegible]
[illegible].1949050E 02	[illegible]	0.5392914E 01	[illegible]
0.1753776E 02	0.3537065E 01	0.5865022E 01	[illegible]
[illegible].1568008E 02	[illegible]	0.6335023E 01	[illegible]
[illegible].1394555E 02	0.3136169E 01	0.6798764E 01	[illegible]
[illegible]	0.2263084E 01	0.7238084E 01	[illegible]
[illegible]	0.2757637E 01	0.7660406E 01	[illegible]
[illegible].9589222E 01	[illegible].2521067E 01	0.8058930E 01	[illegible]
[illegible]	-0.2414189E 01	0.8431725E 01	[illegible]
[illegible]	0.2257300E 01	[illegible]	[illegible]
[illegible]	[illegible]	0.9399266E 01	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.1845163E 01	[illegible]	[illegible].1900000E 01
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.1013672E 02	[illegible]
0.3025016E 01	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.1084660E 02	[illegible]
[illegible]	[illegible]	0.1096166E 02	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.3000000E 01

$\overline{T}_D$ = 0.1200000E 02 $\overline{W}$ = 0.4000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = 0.1200000E 02 $\overline{W}$ = [illegible]

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = 0.1200000E 02 $\overline{W}$ = 0.1500000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1214286E 02	-0.2875000E 01	0.7500000E 01	0.
0.1304939E 02	-0.2989838E 01	0.7230915E 01	-0.3000000E-00
0.1383018E 02	-0.3085393E 01	0.7006337E 01	-0.4000000E-00
0.1494038E 02	-0.3217166E 01	0.6695708E 01	-0.5000000E 00
0.1649172E 02	-0.3393593E 01	0.6278306E 01	-0.6000000E 00
0.1866408E 02	-0.3627537E 01	0.5722507E 01	-0.7000000E 00
0.2176150E 02	-0.3939030E 01	0.4979021E 01	-0.8000000E 00
0.2632691E 02	-0.4360405E 01	0.3967991E 01	-0.9000000E 00
0.3540647E 02	-0.4947555E 01	0.2552447E 01	-0.1000000E 01
0.4523745E 02	-0.5803422E 01	0.4778598E-00	-0.1100000E 01
0.6736586E 02	-0.7143192E 01	-0.2786197E 01	-0.1200000E 01
0.1170112E 03	-0.9500159E 01	-0.8555268E 01	-0.1300000E 01
0.2733835E 03	-0.1465726E 02	-0.2122823E 02	-0.1400000E 01
0.5276361E 03	-0.2045752E 02	-0.3551215E 02	-0.1450000E 01
0.1484528E 04	-0.3447249E 02	-0.7006311E 02	-0.1500000E 01
0.1664587E 05	-0.1159489E 03	-0.2710673E 03	-0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1133877E 02	-0.2768293E 01	0.7749146E 01	0.3000000E-00
0.1074753E 02	-0.2690386E 01	0.7930462E 01	0.4000000E-00
0.1006706E 02	-0.2596161E 01	0.8149040E 01	0.5000000E 00
0.9319633E 01	-0.2489202E 01	0.8396111E 01	0.6000000E 00
0.8537716E 01	0.2373113E 0	0.8662816E 01	0.7000000E 00
0.7750552E 01	-0.2251381E 01	0.8940884E 01	0.8000000E 00
0.6960824E 01	0.2126988E 01	0.9222460E 01	0.9000000E 00
0.6245023E 01	-0.2002535E 01	0.9502535E 01	0.1000000E 01
0.5553965E 01	0.1880103E 01	0.9774925E 01	0.1100000E 01
0.4913608E 01	-0.1761286E 01	0.1003625E 02	0.1200000E 01
0.4326075E 01	0.1647238E 01	0.1028134E 02	0.1300000E 01
0.3790742E 01	-0.1538735E 01	0.1051592E 02	0.1400000E 01
0.3305084E 01	-0.1436240E 01	0.1073154E 02	0.1500000E 01
0.2865423E 01	0.1339971E 01	0.1093235E 02	0.1600000E 01
0.2467473E 01	0.1249959E 01	0.1111298E 02	0.1700000E 01
0.2106759E 01	0.1166091E 01	0.1127813E 02	0.1800000E 01
0.1778839E 01	0.1088163E 01	0.1142427E 02	0.1900000E 01
0.1479519E 01	0.1015904E 01	0.1155361E 02	0.2000000E 01
0.1204921E 01	0.9490015E 00	0.1166510E 02	0.2100000E 01
0.9515359E 00	0.8971768E 00	0.1179358E 02	0.2200000E 01
0.7162541E 00	0.8299748E 00	0.1184935E 02	0.2300000E 01
0.4962511E 00	0.7770963E 00	0.1197527E 02	0.2400000E 01
0.2591652E-00	0.7262839E 00	0.1205112E 02	0.2500000E 01
0.9286647E 01	0.6851965E 00	0.1211814E 02	0.2600000E 01
-0.9447509E 01	0.6415104E 00	0.1217651E 02	0.2700000E 01
0.2744425E 00	0.6029804E 00	0.1222737E 02	0.2800000E 01
-0.4448051E 00	0.5673408E 00	0.1227133E 02	0.2900000E 01
0.6175160E 00	0.5345549E 00	[illegible]	[illegible]

$\overline{T}_D$ = 0.1200000E 02 $\overline{W}$ = 0.1800000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.7885715E 01	-0.2250000E 01	0.9000000E 01	0.
0.8464307E 01	-0.2341096E 01	0.8789302E 01	-0.3000000E-00
0.8963726E 01	-0.2416904E 01	0.8613295E 01	-0.4000000E-00
0.9672099E 01	-0.2521458E 01	0.8369636E 01	0.5000000E 00
0.1066035E 02	-0.2661457E 01	0.8041876E 01	-0.6000000E 00
0.1204737E 02	-0.2847121E 01	0.7604911E 01	-0.7000000E 00
0.1401026E 02	-0.3094371E 01	0.7019603E 01	-0.8000000E 00
0.1690679E 02	-0.3428975E 01	0.6222531E 01	-0.9000000E 00
0.2139260E 02	-0.3895100E 01	0.5104974E 01	-0.1000000E 01
0.2988046E 02	-0.4574808E 01	0.3464482E 01	-0.1100000E 01
0.4287251E 02	-0.5638991E 01	0.8798524E 00	-0.1200000E 01
0.7424220E 02	-0.7511432E 01	-0.3694320E 01	-0.1300000E 01
0.1730076E 03	-0.1160893E 02	-0.1375350E 02	-0.1400000E 01
0.3335699E 03	-0.1621785E 02	-0.2509803E 02	-0.1450000E 01
0.9378210E 03	-0.2735437E 02	-0.5254733E 02	-0.1500000E 01
0.1051162E 05	-0.9209883E 02	-0.2122674E 03	-0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.7380255E 01	-0.2165362E 01	0.9194883E 01	0.3000000E-00
0.6991468E 01	0.2103574E 01	0.9336572E 01	0.4000000E-00
0.6555028E 01	-0.2028854E 01	0.9537214E 01	0.5000000E 00
0.6074882E 01	0.1944047E 01	0.9699857E 01	0.6000000E 00
0.5570988E 01	-0.1852034E 01	0.9902497E 01	0.7000000E 00
0.5062308E 01	0.1755532E 01	0.1012354E 02	0.8000000E 00
0.4563154E 01	0.1656962E 01	0.1034214E 02	0.9000000E 00
0.4003940E 01	-0.1555837E 01	0.1055837E 02	0.1000000E 01
0.3631529E 01	-0.1461414E 01	0.1076831E 02	0.1100000E 01
0.3209705E 01	-0.1367354E 01	0.1096899E 02	0.1200000E 01
0.2819812E 01	-0.1277106E 01	0.1115831E 02	0.1300000E 01
0.2461501E 01	-0.1191285E 01	0.1133472E 02	0.1400000E 01
0.2133179E 01	-0.1110257E 01	0.1149408E 02	0.1500000E 01
0.1812550E 01	-0.1034195E 01	0.1164754E 02	0.1600000E 01
0.1556933E 01	-0.9631197E 00	0.1179342E 02	0.1700000E 01
0.1303512E 01	-0.8969421E 00	[illegible]	0.1800000E 01
0.1067569E 01	0.8354966E 00	0.1201614E 02	0.1900000E 01
0.8522913E 00	-0.7785656E 00	0.1213426E 02	0.2000000E 01
0.6494225E 00	-0.7259027E 00	0.1222122E 02	0.2100000E 01
0.4507223E-00	0.6772366E 00	0.1229752E 02	0.2200000E 01
0.2702087E-00	0.6321024E 00	0.1236448E 02	0.2300000E 01
0.1061573E-00	0.5903102E 00	0.1240315E 02	0.2400000E 01
-0.5074826E-01	-0.5525600E 00	0.1245350E 02	0.2500000E 01
-0.2194316E-00	0.5172635E 00	0.1249657E 02	0.2600000E 01
[illegible]	0.4846657E 00	0.1253107E 02	0.2700000E 01
0.5248950E 00	-0.4555475E 00	0.1256165E 02	0.2800000E 01
0.5715337E 00	0.4257450E 00	0.1258992E 02	0.2900000E 01
0.8220215E 00	0.4012454E 00	0.1260761E 02	0.3000000E 01

$\overline{T}_D$ = [illegible] $\overline{W}$ = [illegible]

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	0.
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = [illegible] $\overline{W}$ = 0.2400000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = 0.1600000E 02 $\overline{W}$ = 0.

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{\lambda}$	$\overline{M}$	$\overline{y}$
0.8533333E 02	-0.9000000E 01	0.	0.
0.9184519E 02	-0.8311396E 01	-0.7482257E 00	0.3000000E-00
0.9744352E 02	-0.8570444E 01	0.1371271E 01	-0.4000000E 00
0.1054325E 03	-0.8927611E 01	0.2231903E 01	-0.5000000E 00
0.1166165E 03	-0.9405702E 01	0.3396053E 01	-0.6000000E 00
0.1323084E 03	-0.1003949E 02	-0.4919349E 01	-0.7000000E 00
0.1547281E 03	-0.1083112E 02	-0.6965197E 01	0.9000000E 00
0.1878403E 03	-0.1202421E 02	0.9719613E 01	0.9000000E 00
0.2392849E 03	-0.1361305E 02	0.1361305E 02	-0.1000000E 01
0.3253995E 03	-0.1592865E 02	0.1927387E 02	0.1100000E 01
0.4866849E 03	-0.1955226E 02	0.2815524E 02	0.1200000E 01
0.8488909E 03	-0.2572526E 02	0.4581335E 02	0.1300000E 01
0.1990472E 04	0.3986522E 02	0.7811558E 02	0.1400000E 01
0.3467030E 04	0.5554198E 02	0.1167772E 03	0.1450000E 01
0.1093481E 05	-0.9361768E 02	0.2201493E 03	0.1500000E 01
0.1217584E 06	0.3115992E 03	0.7534227E 03	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{\lambda}$	$\overline{M}$	$\overline{y}$
0.7049[illegible] 02	[illegible]	[illegible]	[illegible]
0.7536021E 02	0.7672254E 01	[illegible]	[illegible]
0.7050505E 02	0.7243551E 01	[illegible]	[illegible]
0.6518618E 02	[illegible]	0.2503192E 01	[illegible]
0.5968547E 02	0.6630182E 01	[illegible]	[illegible]
0.5409149E 02	0.6137152E 01	0.4236840E 01	[illegible]
0.4868776E 02	0.5989448E 01	0.4845724E 01	[illegible]
0.4356087E 02	0.5537112E 01	[illegible]	[illegible]
0.3878280E 02	[illegible]	0.5841265E 01	[illegible]
0.3439930E 02	0.4927459E 01	0.7163421E 01	[illegible]
0.3[illegible]552E 02	0.4465872E 01	0.7841342E 01	[illegible]
0.2695064E 02	0.4167034E 01	0.9456129E 01	[illegible]
0.2367139E 02	[illegible]	[illegible]	[illegible]
0.2084912E 02	0.3825116E 01	0.1179213E 02	[illegible]
0.1835208E 02	0.3579845E 01	0.1034772E 02	[illegible]
0.1614915E 02	0.3342112E 01	0.1194112E 02	[illegible]
0.1420773E 02	0.3135327E 01	0.1113185E 02	[illegible]
0.1249698E 02	0.2730721E 01	0.1174716E 02	[illegible]
0.1098600E 02	[illegible]	0.1211929E 02	[illegible]
0.9655330E 01	0.2502342E 01	0.1249733E 02	[illegible]
0.8475589E 01	[illegible]	0.1262364E 02	0.2100000E 01
0.7428461E 01	[illegible]	0.1312372E 02	[illegible]
0.6492369E 01	0.2142535E 01	0.1319036E 02	[illegible]
0.5862811E 01	-0.2017272E 01	0.1161625E 02	0.2500000E 01
0.4215227E 01	0.1903111E 01	0.1145239E 02	[illegible]
0.4241555E 01	0.1793536E 01	0.1361125E 02	[illegible]
0.3631712E 01	0.1697760E 01	0.1424457E 02	0.2900000E 01
0.[illegible] 01	0.1601195E 01	0.1441075E 02	0.3000000E 01

$\overline{T}_D$ = 0.1600000E 02 $\overline{W}$ = 0.3000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{\lambda}$	$\overline{M}$	$\overline{y}$
0.7101905E 02	-0.7375000E 01	0.1500000E 01	0.
0.7858210E 02	-0.7662654E 01	0.9103612E 00	-0.3000000E 00
0.8336460E 02	-0.7901955E 01	0.2356872E-00	-0.4000000E-00
0.9018890E 02	-0.8231903E 01	0.5579757E 00	-0.5000000E 00
0.9974189E 02	-0.8673566E 01	0.1622484E 01	0.6000000E 00
0.1131445E 03	-0.9259070E 01	-0.3036944E 01	-0.7000000E 00
0.1322920E 03	-0.1003945E 02	-0.4924505E 01	0.4000000E 00
0.1615695E 03	-0.1109260E 02	-0.7485073E 01	-0.9000000E 00
0.2044999E 03	-0.1256060E 02	0.1106060E 02	0.1000000E 01
0.2700321E 03	-0.1470094E 02	0.1628705E 02	-0.1100000E 01
0.4157455E 03	-0.1804406E 02	0.2448921E 02	0.1200000E 01
0.7250045E 03	-0.2393633E 02	-0.3895240E 02	0.1300000E 01
0.1699690E 04	0.3691883E 02	0.7065111E 02	0.1400000E 01
0.3284811E 04	0.5130221E 02	0.1063629E 03	0.1450000E 01
0.9250936E 04	0.8627745E 02	0.1726735E 03	0.1500000E 01
0.1137830E 06	-0.269[illegible]491E 03	-0.6946222E 03	0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{\lambda}$	$\overline{M}$	$\overline{y}$
[illegible]	[illegible]	0.2137692E 01	[illegible]
0.6449813E 02	[illegible]	0.2652291E 01	[illegible]
0.6034948E 02	0.6675285E 01	0.3159071E 01	[illegible]
0.5580426E 02	0.6608149E 01	0.3826935E 01	0.6000000E 00
0.5125830E 02	0.6117049E 01	0.4497117E 01	0.7200000E 00
0.4652151E 02	0.5841635E 01	0.5214458E 01	0.8000000E 00
0.4170347E 02	0.5499463E 01	0.5954565E 01	0.9000000E 00
0.3731744E 02	0.5146949E 01	0.6659769E 01	0.1000000E 01
0.3323064E 02	0.4979373E 01	0.7606042E 01	0.1100000E 01
0.2947278E 02	0.4558066E 01	0.8296159E 01	0.1200000E 01
0.2607848E 02	0.4223372E 01	0.8756415E 01	0.1300000E 01
0.2302180E 02	0.4022055E 01	0.9340245E 01	0.1400000E 01
0.2022942E 02	0.3752223E 01	0.9965032E 01	0.1500000E 01
0.1787242E 02	0.3519583E 01	0.1055295E 02	0.1600000E 01
0.1572939E 02	0.3292020E 01	0.1101372E 02	0.1700000E 01
0.1387695E 02	0.3107963E 01	0.1147908E 02	0.1800000E 01
0.1216724E 02	0.2992561E 01	0.1190064E 02	0.1900000E 01
0.1069386E 02	0.2699653E 01	0.1224761E 02	0.2000000E 01
0.9392417E 01	0.2529572E 01	0.1265541E 02	0.2100000E 01
0.8240817E 01	0.2317217E 01	0.1298144E 02	0.2200000E 01
0.7219615E 01	0.2226497E 01	0.1327017E 02	0.2300000E 01
0.6310743E 01	0.2074163E 01	0.1354751E 02	0.2400000E 01
0.5449567E 01	0.1966914E 01	0.1379254E 02	0.2500000E 01
0.4722592E 01	-0.1845159E 01	0.1403145E 02	0.2600000E 01
0.4110202E 01	0.1748240E 01	0.1421555E 02	[illegible]
0.3526652E 01	0.1645091E 01	0.1441753E 02	[illegible]
0.2459390E 01	0.1553167E 01	0.1456210E 02	0.2900000E 01
0.2448132E 01	0.1467986E 01	0.1477098E 02	0.3000000E 01

$\overline{T}_D$ = [illegible] $\overline{W}$ = [illegible]

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{\lambda}$	$\overline{M}$	$\overline{y}$
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{\lambda}$	$\overline{M}$	$\overline{y}$
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = [illegible] $\overline{W}$ = [illegible]

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{\lambda}$	$\overline{M}$	$\overline{y}$
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{\lambda}$	$\overline{M}$	$\overline{y}$
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-1 (Cont'd)
VALUES OF $\bar{\lambda}$, $\bar{y}$ AND $\bar{M}$ FOR SPECIFIED VALUES OF $\bar{T}_d$, $\bar{T}$ AND $\bar{W}$

$\bar{T}_D$ = 0.1600000E 02 $\bar{W}$ = 0.1200000E 02

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.4190476E 02	-0.5500000E 01	0.6000000E 01	0.
0.4507047E 02	-0.5716428E 01	0.5485521E 01	-0.1000000E 00
0.4772275E 02	-0.5896491E 01	0.5056561E 01	-0.4000000E-00
0.5167500E 02	-0.6144777E 01	0.4463806E 01	-0.5000000E 00
0.5710779E 02	-0.6477156E 01	0.3668224E 01	-0.6000000E 00
0.6472726E 02	-0.6917824E 01	0.2610267E 01	-0.7000000E 00
0.7560846E 02	-0.7504466E 01	0.1197142E 01	-0.8000000E 00
0.9167366E 02	-0.8298090E 01	-0.7214528E 00	-0.9000000E 00
0.1166227E 03	-0.9403263E 01	0.3403263E 01	-0.1000000E 01
0.1583712E 03	-0.1101420E 02	0.7327180E 01	0.1100000E 01
0.2365406E 03	-0.1355546E 02	0.1349106E 02	-0.1200000E 01
0.4120527E 03	-0.1797015E 02	0.2436955E 02	0.1300000E 01
0.9651495E 03	-0.2767190E 02	-0.4823692E 02	-0.1400000E 01
0.1864610E 04	-0.3858289E 02	-0.7512053E 02	-0.1450000E 01
0.5249980E 04	0.6494478E 02	-0.1401262E 03	0.1500000E 01
0.5989022E 05	0.2181988E 01	-0.5182226E 01	-0.1550000E 01
TENSILE END LOADS			
0.1907217E 02	0.5278571E 01	0.6476398E 01	0.3000000E-00
0.1705165E 02	0.5152010E 01	0.6824321E 01	0.4000000E 00
0.1468819E 02	-0.4974345E 01	0.7243591E 01	0.5000000E 00
[illegible]	[illegible]	[illegible]	[illegible]

$\bar{T}_D$ = 0.1600000E 02 $\bar{W}$ = 0.1500000E 02

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.3347619E 02	-0.4875000E 01	0.7500000E 01	0.
0.3599242E 02	-0.5067637E 01	0.7043908E 01	-0.3000000E 00
0.3815712E 02	-0.5228003E 01	0.6663519E 01	-0.4000000E-00
0.4124265E 02	-0.5449069E 01	0.6137733E 01	-0.5000000E 00
0.4555956E 02	-0.5745019E 01	0.5431793E 01	0.6000000E 00
0.5161307E 02	-0.6137408E 01	0.4492670E 01	-0.7000000E 00
0.6025641E 02	-0.6659807E 01	0.3237724E 01	-0.8000000E 00
0.7301395E 02	0.7366559E 01	0.1533087E 01	0.7000000E 00
0.9782295E 02	-0.8350816E 01	0.8508157E 00	-0.1000000E 01
0.1259647E 03	0.9785585E 01	0.4340557E [illegible]	-0.1100000E 01
0.1880100E 03	0.1203126E 02	0.9825011E 01	-0.1200000E 01
0.3273044E 03	0.1598142E 02	-0.1950860E 02	-0.1300000E 01
0.7662388E 03	0.2552357E 02	-0.4076219E 02	0.1400000E 01
0.1480029E 04	0.3434112E 02	0.6470541E 02	0.1450000E 01
0.4166553E 04	-0.5742686E 02	0.1276104E 03	0.1500000E 01
0.4673345E 05	0.1264457E 03	0.4596228E 03	0.1550000E 01
TENSILE END LOADS			
0.3122914E 02	0.4695964E 01	0.7922615E 01	0.3000000E 00
0.2961620E 02	0.4565200E 01	0.8210432E 01	0.4000000E 00
0.2773624E 02	0.4407059E 01	0.8601765E [illegible]	0.5000000E 00
0.2567506E 02	0.4227527E 01	0.9021910E 01	0.6000000E 00
[illegible]	[illegible]	[illegible]	[illegible]

$\bar{T}_D$ = [illegible] $\bar{W}$ = [illegible]

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

$\bar{T}_D$ = [illegible] $\bar{W}$ = [illegible]

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{\overline{T}}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_d$ = 0.16000000E 02 W = 0.24000000E 02

COMPRESSIVE END LOADS

T	Y	M	λ
0.14017051E 02	-0.30000000E 01	0.12000000E 02	0.
0.15035581E 02	-0.31214600E 01	0.11719071E 02	0.30000000E [illegible]
0.15915013E 02	-0.32225539E [illegible]	0.11464539E 02	0.40000000E [illegible]
0.17162398E 02	0.33619431E 01	0.11159251E 02	-0.50000000E [illegible]
0.18905061E 02	0.35486098E 01	[illegible]12722501E 02	0.60000000E [illegible]
0.21345128E 02	0.37961611E [illegible]	[illegible]2139081E [illegible]	0.70000000E [illegible]
0.24824188E 02	0.41258[illegible]	0.91596701E 01	0.80000000E [illegible]
0.29951528E 02	0.45719601E [illegible]	0.82967071E 01	0.90000000E [illegible]
0.37901661E 02	0.51936761E [illegible]	0.64065261E 01	0.10000000E 01
0.51186191E 02	0.52997841E [illegible]	[illegible]4619110E 01	[illegible]
0.76031121E 02	0.75186551E 01	[illegible]	[illegible]
0.13176711E 03	0.10015241E 02	0.42257601E 01	[illegible]
0.30731150E 03	0.15429557E 02	0.14339001E 02	[illegible]
0.59274061E 03	0.2162381[illegible]	0.33465404E 02	[illegible]
0.16669461E 04	[illegible]	[illegible]	[illegible]
0.14687011E 05	0.12277884E [illegible]	[illegible]	[illegible]

TENSILE END LOADS

T	Y	M	λ
0.13113261E 02	0.28175501E 01	[illegible]	[illegible]
0.12450001E 02	0.29067601E 01	[illegible]	[illegible]
0.11685781E 02	[illegible]	[illegible]	[illegible]
0.10840671E 02	[illegible]	0.12933141E 02	[illegible]
0.99678481E 01	[illegible]	0.13210501E 02	[illegible]
0.90826181E 01	[illegible]	0.15493051E 02	[illegible]
0.82172711E 01	[illegible]	[illegible]	[illegible]
0.73899601E 01	[illegible]	0.14017931E 02	[illegible]
0.66129071E 01	[illegible]	0.14357751E 02	[illegible]
0.58928111E 01	[illegible]	[illegible]	[illegible]
0.52320751E 01	[illegible]	[illegible]	[illegible]
0.46100751E 01	0.15881791E 01	[illegible]	[illegible]
0.40634081E 01	[illegible]	[illegible]	[illegible]
0.35897191E 01	[illegible]	[illegible]	[illegible]
0.31425101E 01	[illegible]	[illegible]	[illegible]
0.27373511E 01	[illegible]	[illegible]	[illegible]
0.23493101E 01	0.11119475E 01	0.16021521E 02	[illegible]
0.22337031E 01	[illegible]	0.16152151E 02	[illegible]
0.17262081E 01	[illegible]	0.16238101E 02	[illegible]
0.14429141E 01	[illegible]	0.16370431E 02	[illegible]
0.11903341E 01	[illegible]	[illegible]	[illegible]
0.91359071E 00	[illegible]	0.15531561E 02	[illegible]
0.73518651E 00	0.73674571E 00	0.16606471E 02	[illegible]
0.48747331E-00	0.68965901E 00	0.15662391E 02	[illegible]
0.28111471E 00	[illegible]	0.16713741E 02	[illegible]
0.81050301E-01	[illegible]	0.16751561E 02	[illegible]
0.10774141E 00	0.56589101E 00	0.16735521E 02	[illegible]
0.29257181E-00	0.53467272E 00	[illegible]	[illegible]

$\overline{T}_d$ = 0.20000000E 02

COMPRESSIVE END LOADS

T	Y	M	λ
0.11333333E 03	0.10000000E 02	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

T	Y	M	λ
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_d$ = 0.20000000E 02 W = [illegible]

COMPRESSIVE END LOADS

T	Y	M	λ
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

T	Y	M	λ
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_d$ = [illegible] W = [illegible]

COMPRESSIVE END LOADS

T	Y	M	λ
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

T	Y	M	λ
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-1 (Cont'd)
VALUES OF $\bar{\lambda}$, $\bar{y}$ AND $\bar{M}$ FOR SPECIFIED VALUES OF $\bar{T}_d$, $\bar{T}$ AND $\bar{W}$

$\bar{T}_D$ = 0.2000000E 02 $\bar{W}$ = 0.9000000E 01

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.8970476E 02	-0.8125000E 01	0.4500000E 01	0.
0.9650953E 02	-0.8443019E 01	0.3740128E 01	-0.3000000E-00
0.1023604E 03	-0.8707590E 01	0.3100786E 01	-0.4000000E-00
0.1107088E 03	-0.9072389E 01	0.2231903E 01	-0.5000000E 00
0.1223952E 03	-0.9540716E 01	0.1058142E 01	0.6000000E 00
0.1387913E 03	-0.1020811E 02	-0.5019741E 00	-0.7000000E 00
0.1622158E 03	-0.1106903E 02	-0.2584737E 01	-0.8000000E 00
0.1968100E 03	-0.1223567E 02	-0.5410896E 01	-0.9000000E 00
0.2505541E 03	-0.1385897E 02	0.9358973E 01	-0.1000000E 01
0.3405136E 03	-0.1622497E 02	-0.1513222E 02	-0.1100000E 01
0.5089433E 03	-0.1992772E 02	-0.2419592E 02	-0.1200000E 01
0.8873444E 03	-0.2644014E 02	-0.4018384E 02	-0.1300000E 01
0.2079785E 04	-0.4068653E 02	-0.7524561E 02	-0.1400000E 01
0.4019041E 04	0.5670816E 02	0.1147289E 03	-0.1450000E 01
0.1131807E 05	0.9541748E 02	0.2101893E 03	0.1500000E 01
0.1269697E	-0.1236497E 03	0.7653785E 03	0.1550000E 01
TENSILE END LOADS			
0.8360725E 02	0.7829451E 01	0.5204550E 01	0.1000000E 00
0.7920101E 02	0.7511615E 01	0.5718182E 01	0.4000000E 00
0.7420655E 02	0.7352572E 01	0.6531142E 01	0.5000000E 00
0.6864708E 02	0.7056151E 01	0.7240218E 01	0.5000000E 00
[illegible]	[illegible]	[illegible]	[illegible]

$\bar{T}_D$ = 0.2000000E 02 $\bar{W}$ = 0.1200000E 02

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.7710476E 02	-0.7500000E 01	0.6000000E 01	0.
0.8293878E 02	-0.7794277E 01	0.5298515E 01	-0.3000000E 00
0.8795553E 02	-0.8039102E 01	0.4713744E 01	-0.4000000E-00
0.9511234E 02	-0.8376680E 01	0.3205830E 01	-0.5000000E 00
0.1051304E 03	-0.8828581E 01	0.2821711E 01	-0.6000000E 00
0.1191846E 03	-0.9427695E 01	0.1180429E 01	-0.7000000E 00
0.1392619E 03	-0.1022524E 02	-0.5441551E 00	-0.8000000E 00
0.1689107E 03	-0.1130414E 02	-0.3156356E 01	0.9000000E 00
0.2149685E 03	-0.1280653E 02	-0.6806526E 01	-0.1000000E 01
0.2920575E 03	-0.1499636E 02	0.1214560E 02	-0.1100000E 01
0.4364254E 03	-0.1842352E 02	0.2052987E 02	-0.1200000E 01
0.7606167E 03	-0.2445141E 02	-0.3532289E 02	-0.1300000E 01
0.1782340E 04	-0.3763820E 02	-0.6777088E 02	0.1400000E 01
0.3443944E 04	-0.5246839E 02	0.1045148E 03	0.1450000E 01
0.9697919E 04	-0.8829435E 02	-0.1926735E 03	0.1500000E 01
0.1387908E [illegible]	-0.2965986E 03	-0.7065701E 03	0.1550000E 01
TENSILE END LOADS			
0.7148042E 02	-0.7226521E 01	0.6650387E 01	0.3000000E-00
0.6815610E 02	0.7026824E 01	0.7124272E 01	0.4000000E 00
0.6381467E 02	0.6785263E 01	0.7676116E 01	0.5000000E 00
0.5906573E 02	0.6511008E 01	0.8343765E 01	0.6000000E [illegible]
0.5427655E 02	-0.6213331E 01	0.9234553E 01	0.7000000E [illegible]
[illegible]	[illegible]	[illegible]	[illegible]

$\bar{T}_D$ = [illegible] $\bar{W}$ = [illegible]

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

$\bar{T}_D$ = [illegible] $\bar{W}$ = [illegible]

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-1 (Cont'd)

VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

T_D = 0.20000000E 02   [illegible]

COMPRESSIVE [illegible]

[illegible]	[illegible]	[illegible]	[illegible]
0.48503380E 02	0.5846305 E 01	0.29736758	[illegible]
0.51405312E 02	0.6033354 E 01	[illegible]	[illegible]
0.55519960E 02	0.6.495 E 01	[illegible]	[illegible]
0.61125580E 02	[illegible]	[illegible]	[illegible]
0.69439260E 02	[illegible]	[illegible]	[illegible]
0.81025810E 02	[illegible]	[illegible]	[illegible]
0.98129450E 02	[illegible]	[illegible]	[illegible]
0.12468960E 03	[illegible]	[illegible]	[illegible]
0.16911010E 03	[illegible]	[illegible]	[illegible]
0.25233430E 03	[illegible]	[illegible]	[illegible]
0.43918170E 03	[illegible]	[illegible]	[illegible]
0.10275120E 04	[illegible]	[illegible]	[illegible]
0.14851110E 04	[illegible]	[illegible]	[illegible]
0.55081500E 04	[illegible]	[illegible]	[illegible]
0.62677290E 05	[illegible]	[illegible]	[illegible]

TENSILE [illegible]

[illegible]	[illegible]	[illegible]	[illegible]

COMPRESSIVE [illegible]

[illegible]	[illegible]	[illegible]	[illegible]

TENSILE [illegible]

[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-1 (Cont'd)
VALUES OF $\bar{\lambda}$, $\bar{y}$ AND $\bar{M}$ FOR SPECIFIED VALUES OF $\bar{T}_d$, $\bar{T}$ AND $\bar{W}$

$\bar{T}_D$ = -0.4000000E 01 $\bar{W}$ = 0.6000000E 01

COMPRESSIVE END LOADS

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
0.1367619E 02	0.3250000E 01	0.3000000E 01	0.
0.1474003E 02	0.3375333E 01	0.3303780E 01	-0.3000000E-00
0.1565401E 02	0.3479587E 01	0.3556734E 01	-0.4000000E-00
0.1695670E 02	0.3625320E 01	0.3905650E 01	-0.5000000E 00
0.1877824E 02	0.3815699E 01	0.4373652E 01	-0.6000000E 00
0.2133001E 02	0.4070703E 01	0.4994644E 01	-0.7000000E 00
0.2497311E 02	0.4410096E 01	0.5822461E 01	-0.8000000E 00
0.3034577E 02	0.4869115E 01	0.6943983E 01	-0.9000000E 00
0.3868330E 02	0.5508157E 01	0.8508157E 01	-0.1000000E 01
0.5262566E 02	0.6439390E 01	0.1079166E 02	-0.1100000E 01
0.7871733E 02	0.7896467E 01	0.1437091E 02	-0.1200000E 01
0.1372781E 03	0.1045872E 02	0.2067523E 02	-0.1300000E 01
0.3217802E 03	0.1606297E 02	0.3468342E 02	-0.1400000E 01
0.6217983E 03	0.2236504E 02	0.5002250E 02	-0.1450000E 01
0.1750968E 04	0.3759062E 02	0.6757809E 02	-0.1500000E 01
0.1964218E 05	0.1261000E 03	0.3059552E 03	-0.1550000E 01

TENSILE END LOADS

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
0.1272251E 02	0.3133509E 01	0.2717984E 01	0.3000000E-00
0.1204362E 02	0.3048436E 01	0.2512250E 01	0.4000000E-00
0.1124732E 02	0.2945511E 01	0.2263622E 01	0.5000000E 00
0.1037348E 02	0.2828635E 01	0.1981691E 01	0.6000000E 00
0.9461085E 01	0.2701750E 01	0.1676143E 01	0.7000000E 00
0.8543907E 01	0.2568574E 01	0.1356113E 01	0.8000000E 00
0.7668674E 01	0.2432424E 01	0.1029737E 01	0.9000000E 00
0.6794633E 01	0.2296109E 01	0.7038915E 00	0.1000000E 01
0.5975069E 01	0.2161895E 01	0.3841095E-00	0.1100000E 01
0.5256344E 01	0.2031514E 01	0.7461902E-01	0.1200000E 01
0.4581125E 01	0.1906233E 01	-0.2215336E-00	0.1300000E 01
0.3968598E 01	0.1786897E 01	-0.5023[illegible]91E 00	0.1400000E 01
0.3415723E 01	0.1674017E 01	-0.7665386E 00	0.1500000E 01
0.2918097E 01	0.1567036E 01	-0.1013661E 01	0.1600000E 01
0.2470605E 01	0.1468393E 01	-0.1243656E 01	0.1700000E 01
0.2067890E 01	0.1375575E 01	-0.1456864E 01	0.1800000E 01
0.1704671E 01	0.1289165E 01	-0.1653885E 01	0.1900000E 01
0.1375935E 01	0.1208874E 01	-0.1835494E 01	0.2000000E 01
0.1077056E 01	0.1134370E 01	-0.2002570E 01	0.2100000E 01
0.8038451E 00	0.1065298E 01	-0.2156043E 01	0.2200000E 01
0.5525630E 00	0.1001297E 01	-0.2296863E 01	0.2300000E 01
0.3199061E-00	0.9420081E 00	-0.2425967E 01	0.2400000E 01
0.1029787E-00	0.8870821E 00	-0.2544263E 01	0.2500000E 01
-0.1007428E-00	0.8361865E 00	-0.2652620E 01	0.2600000E 01
-0.2934484E-00	0.7890064E 00	-0.2751857E 01	0.2700000E 01
-0.4770337E-00	0.7452471E 00	-0.2842739E 01	0.2800000E 01
-0.6531356E 00	0.7046350E 00	-0.2925981E 01	0.2900000E 01
-0.8231661E 00	0.6669156E 00	-0.3002240E 01	0.3000000E 01

$\bar{T}_D$ = -0.4000000E 01 $\bar{W}$ = 0.9000000E 01

COMPRESSIVE END LOADS

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
0.1930476E 02	0.3875000E 01	0.4500000E 01	0.
0.2080222E 02	0.4024075E 01	0.4862167E 01	-0.3000000E-00
0.2208959E 02	0.4148075E 01	0.5163692E 01	-0.4000000E-00
0.2392495E 02	0.4319028E 01	0.5579757E 01	-0.5000000E 00
0.2649240E 02	0.4547836E 01	0.6137221E 01	-0.6000000E 00
0.3009195E 02	0.4851118E 01	0.6877048E 01	-0.7000000E 00
0.3523076E 02	0.5254755E 01	0.7863043E 01	-0.8000000E 00
0.4281454E 02	0.5800648E 01	0.9198523E 01	-0.9000000E 00
0.5458885E 02	0.6560604E 01	0.1106060E 02	-0.1000000E 01
0.7428553E 02	0.7668004E 01	0.1377828E 02	-0.1100000E 01
0.1111579E 03	0.9400668E 01	0.1803696E 02	-0.1200000E 01
0.1939342E 03	0.1244744E 02	0.2553618E 02	-0.1300000E 01
0.4547669E 03	0.1911130E 02	0.4195515E 02	-0.1400000E 01
0.8789276E 03	0.2660481E 02	0.6043662E 02	-0.1450000E 01
0.2475358E 04	0.4470874E 02	0.1050947E 03	-0.1500000E 01
0.2777026E 05	0.1499301E 03	0.3647550E 03	-0.1550000E 01

TENSILE END LOADS

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
0.1796434E 02	0.3736440E 01	0.4163720E 01	0.3000000E-00
0.1700792E 02	0.3635247E 01	0.3918360E 01	0.4000000E-00
0.1588859E 02	0.3512817E 01	0.3621796E 01	0.5000000E 00
0.1466103E 02	0.3373791E 01	0.3285435E 01	0.6000000E 00
0.1338034E 02	0.3222851E 01	0.2920803E 01	0.7000000E 00
0.1209430E 02	0.3064423E 01	0.2538769E 01	0.8000000E 00
0.1084071E 02	0.2902450E 01	0.2149016E 01	0.9000000E 00
0.9647055E 01	0.2740271E 01	0.1759729E 01	0.1000000E 01
0.8531267E 01	0.2580582E 01	0.1377496E 01	0.1100000E 01
0.7503187E 01	0.2425447E 01	0.1007356E 01	0.1200000E 01
0.6566299E 01	0.2276366E 01	0.6529418E 00	0.1300000E 01
0.5719448E 01	0.2134347E 01	0.3166789E-00	0.1400000E 01
0.4958353E 01	0.2000000E 01	-0.	0.1500000E 01
0.4276727E 01	0.1873613E 01	-0.2964480E-00	0.1600000E 01
0.3667397E 01	0.1755231E 01	-0.5726185E 00	0.1700000E 01
0.3122765E 01	0.1644724E 01	-0.8289051E 00	0.1800000E 01
0.2635360E 01	0.1541831E 01	-0.1066011E 01	0.1900000E 01
0.2198094E 01	0.1446211E 01	-0.1284846E 01	0.2000000E 01
0.1804423E 01	0.1357470E 01	-0.1486443E 01	0.2100000E 01
0.1448424E 01	0.1275186E 01	-0.1671901E 01	0.2200000E 01
0.1124807E 01	0.1198930E 01	-0.1842338E 01	0.2300000E 01
0.8288986E 00	0.1128274E 01	-0.1998860E 01	0.2400000E 01
0.5566043E 00	0.1062806E 01	-0.2142538E 01	0.2500000E 01
0.3043543E-00	0.1002125E 01	-0.2274395E 01	0.2600000E 01
0.6905039E-01	0.9458709E 00	-0.2395399E 01	0.2700000E 01
-0.1519883E-00	0.8936003E 00	-0.2506453E 01	0.2800000E 01
-0.3610772E-00	0.8452318E 00	-0.2608399E 01	0.2900000E 01
-0.5602139E 00	0.8002240E 00	-0.2702016E 01	0.3000000E 01

$\bar{T}_D$ = -0.4000000E 01 $\bar{W}$ = 0.1200000E 02

COMPRESSIVE END LOADS

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
0.2590476E 02	0.4500000E 01	0.6000000E 01	0.
0.2791063E 02	0.4672816E 01	0.6420554E 01	-0.3000000E-00
0.2963607E 02	0.4816563E 01	0.6770650E 01	-0.4000000E-00
0.3209603E 02	0.5014737E 01	0.7253684E 01	-0.5000000E 00
0.3553821E 02	0.5279972E 01	0.7900790E 01	-0.6000000E 00
0.4036554E 02	0.5631534E 01	0.8759452E 01	-0.7000000E 00
0.4725931E 02	0.6099415E 01	0.9703626E 01	-0.8000000E 00
0.5743610E 02	0.6732177E 01	0.1145306E 02	-0.9000000E 00
0.7324032E 02	0.7613052E 01	0.1361305E 02	-0.1000000E 01
0.9968559E 02	0.8876618E 01	0.1676491E 02	-0.1100000E 01
0.1492005E 03	0.1090487E 02	0.2170301E 02	-0.1200000E 01
0.2603747E 03	0.1443617E 02	0.3019713E 02	-0.1300000E 01
0.6107217E 03	0.2215963E 02	0.4963288E 02	-0.1400000E 01
0.1180466E 04	0.3084459E 02	0.7065074E 02	-0.1450000E 01
0.3324859E 04	0.5182686E 02	0.1226104E 03	-0.1500000E 01
0.3730218E 05	0.1738002E 03	0.4235549E 03	-0.1550000E 01

TENSILE END LOADS

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
0.2411132E 02	0.4339370E 01	0.5609457E 01	0.3000000E 00
0.2282892E 02	0.4222058E 01	0.5324471E 01	0.4000000E 00
0.2133077E 02	0.4080124E 01	0.4979969E 01	0.5000000E 00
0.1968843E 02	0.3918945E 01	0.4589180E 01	0.6000000E 00
0.1797582E 02	0.374[illegible]E 01	0.4165463E 01	0.7000000E 00
0.1625723E 02	0.3560[illegible]E 01	0.3721426E 01	0.8000000E 00
0.1458340E 02	0.3372475E 01	0.3268295E 01	0.9000000E 00
0.1299125E 02	0.3184434E 01	0.2815566E 01	0.1000000E 01
0.1150486E 02	0.299[illegible]270E 01	0.2370383E 01	0.1100000E 01
0.1013746E 02	0.281[illegible]300E 01	0.1940393E 01	0.1200000E 01
0.8893723E 01	0.2646499E 01	0.1527[illegible]17E 01	0.1300000E 01
0.7772089E 01	0.2481798E 01	0.1135576E 01	0.1400000E 01
0.6766784E 01	0.2325903E 01	0.7665386E 00	0.1500000E 01
0.5869437E 01	0.2179309E 01	0.4207550E 00	0.1600000E 01
0.5070330E 01	0.2042070E 01	0.9841385E-01	0.1100000E 01
0.4359284E 01	0.1913872E 01	-0.2009467E 00	0.1000000E 01
0.3726259E 01	0.1794498E 01	-0.4701374E 00	0.1900000E 01
0.3161733E 01	0.1683549E 01	0.7341278E 00	0.2000000E 01
0.2656914E 01	0.1580571E 01	0.9703172E 00	0.2100000E 01
0.2[illegible]843E 01	0.1485074E 01	0.1187760E 01	0.2200000E 01
0.1795412E 01	0.1396562E 01	-0.1387[illegible] 01	0.2300000E 01
0.1425344E 01	0.1314540E 01	-0.1571755E 01	0.2400000E 01
0.1080135E 01	0.1230550E 01	-0.1740812E 01	0.2500000E 01
0.7709892E 00	0.1160072E 01	-0.1896170E 01	0.2600000E 01
0.4937443E-00	0.1102735E 01	-0.2038941E 01	0.2700000E 01
0.2287777E-00	0.1047113E 01	-0.2170167E 01	0.2800000E 01
-0.1896150E-01	0.9850206E 00	-0.2290018E 01	0.2900000E 01
-0.2522177E-00	0.9335325E 00	-0.2401792E 01	0.3000000E 01

$\bar{T}_D$ = -0.4000000E 01 $\bar{W}$ = 0.1500000E 02

COMPRESSIVE END LOADS

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
0.3347619E 02	0.5125000E 01	0.7500000E 01	0.
0.3606559E 02	0.5321559E 01	0.7978940E 01	-0.3000000E-00
0.3829333E 02	0.5405051E 01	0.8377608E 01	-0.4000000E 00
0.4146992E 02	0.5710445E 01	0.8927611E 01	-0.5000000E 00
0.4591560E 02	0.6012109E 01	0.9664359E 01	-0.6000000E 00
0.5215156E 02	0.6411949E 01	0.1064105E 02	-0.7000000E 00
0.6105875E 02	0.6944024E 01	0.1194421E 02	-0.8000000E 00
0.7421043E 02	0.7663708E 01	0.1370760E 02	-0.9000000E 00
0.9463832E 02	0.8665499E [illegible]	0.1616550E 02	0.1000000E 01
0.1288259E 03	0.1012523E 02	0.1975153E 02	0.1100000E 01
0.1928454E 03	0.1240907E 02	0.2536908E 02	0.1200000E 01
0.3365998E 03	0.1642490E 02	0.3525800E 02	0.1300000E 01
0.7896444E 03	0.2520796E 02	0.5690761E 02	0.1400000E 01
0.1526414E 04	0.3508436E 02	0.8126486E 02	0.1450000E 01
0.4299473E 04	0.5894499E 02	0.1401262E 03	0.1500000E 01
0.4823794E 05	0.1976502E 03	0.4823547E 03	0.1550000E 01

TENSILE END LOADS

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
0.3116338E 02	0.4962300E 01	0.7055193E 01	0.3000000E 00
0.2950659E 02	0.4808069E 01	0.6730581E 01	0.4000000E 00
0.2757184E 02	0.4667430E 01	0.6338162E 01	0.5000000E 00
0.2545565E 02	0.4464101E 01	0.5892[illegible]4E 01	0.6000000E 00
0.2324755E 02	0.4265053E 01	0.5410124E 01	0.7000000E 00
0.2103269E 02	0.4056121E 01	0.4904093E 01	0.8000000E 00
0.1887673E 02	0.3842501E 01	0.4507574E 01	0.9000000E 00
0.1602740E 02	0.3628597E 01	0.3871403E 01	0.1000000E 01
0.1491505E 02	0.3417955E 01	0.3386269E 01	0.1100000E 01
0.1315917E 02	0.3213312E 01	0.2872830E 01	0.1200000E 01
0.1156340E 02	0.3016631E 01	0.2401893E 01	0.1300000E 01
0.1012252E 02	0.2829249E 01	0.1956673E 01	0.1400000E 01
0.8841075E 01	0.2651966E 01	0.1533077E 01	0.1500000E 01
0.7696225E 01	0.2485165E 01	0.1137970E 01	0.1600000E 01
0.6679404E 01	0.2328930E 01	0.7694563E 00	0.1700000E 01
0.5777447E 01	0.2183021E 01	0.4270110E 00	0.1800000E 01
0.4777369E 01	0.2047164E 01	0.1097365E 00	0.1900000E 01
0.4266853E 01	0.1920887E 01	0.1835494E 00	0.2000000E 01
0.3634529E 01	0.1803671E 01	-0.4561910E 00	0.2100000E 01
0.3070102E 01	0.1694963E 01	-0.7036157E 00	0.2200000E 01
0.2564380E 01	0.1594195E 01	0.9332895E 00	0.2300000E 01
0.2109241E 01	0.1500807E 01	0.1144656E 01	0.2400000E 01
0.1697570E 01	0.1414254E 01	0.1339086E 01	0.2500000E 01
0.1323162E 01	0.1334015E 01	0.1517944E 01	0.2600000E 01
0.9806333E 00	0.1259600E 01	0.1682482E 01	0.2700000E 01
0.6653744E 00	0.1190546E 01	0.1833881E 01	0.2800000E 01
0.3732113E 00	0.1126425E 01	0.1973237E 01	0.2900000E 01
0.1000224E-00	0.1066841E 01	0.2101568E 01	0.3000000E 01

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = -0.4000000E 01 $\overline{W}$ = 0.1800000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.4201905E 02	0.5750000E 01	0.9000000E 01	0.
0.4526657E 02	0.5970301E [illegible]	0.9537327E 01	-0.3000000E 00
0.4806130E 02	0.6153539E 01	0.9984566E 01	-0.4000000E-00
0.5204661E 02	0.6400154E 01	0.1060154E 02	-0.5000000E 00
0.5762465E 02	0.6744246E 01	0.1142793E 02	-0.6000000E 00
0.6545003E 02	0.7192365E 01	0.1252426E 02	-0.7000000E 00
0.7662910E 02	0.7780734E 01	0.1398479E 02	-0.8000000E 00
0.9313756E 02	0.8595239E 01	0.1596214E 02	-0.9000000E 00
0.1187826E 03	0.9717946E 01	0.1871795E 02	[illegible]
0.1617063E 03	0.1135384E 02	0.2273815E 02	[illegible]
0.2420924E 03	0.1391327E 02	0.2903511E 02	[illegible]
0.4226095E 03	0.1841362E 02	0.4011902E 02	0.1300000E 01
0.9915353E 03	0.2825629E 02	0.6438233E 02	-0.1400000E 01
0.1216771E 04	0.3932413E 02	0.9167899E 02	-0.1450000E 01
0.5199199E 04	0.6606311E 02	0.1576420E 03	-0.1500000E 01
0.6057755E 05	0.2215003E 03	0.5411546E 03	0.1550000E 01
TENSILE END LOADS			
0.3912062E 02	0.5545231E 01	0.8500929E 01	0.3000000E 00
0.3704092E 02	0.5395680E 01	0.8136691E 01	0.4000000E-00
0.3461780E 02	0.5214737E 01	0.7696316E 01	0.5000000E 00
0.3196276E 02	0.5039255E 01	0.7196668E 01	0.6000000E 00
0.2919550E 02	0.4786154E 01	0.6654784E 01	0.7000000E 00
0.2642069E 02	0.4551970E 01	0.6086739E 01	0.8000000E 00
0.2372072E 02	0.4312527E 01	0.5506853E 01	0.9000000E 00
0.2115553E 02	0.4072760E 01	0.4927240E 01	0.1000000E 01
0.1876424E 02	0.3836648E 01	0.4357656E 01	0.1100000E 01
0.1656831E 02	0.3607245E 01	0.3805568E 01	0.1200000E 01
0.1457532E 02	0.3386764E 01	0.3276369E 01	0.1300000E 01
0.1278275E 02	0.3176699E 01	0.2773670E 01	0.1400000E 01
0.1118121E 02	0.2977948E 01	0.2299616E 01	0.1500000E 01
0.9757091E 01	0.2790941E 01	0.1855191E 01	0.1600000E 01
0.8494619E 01	0.2615746E 01	0.1440494E 01	0.1700000E 01
0.7377255E 01	0.2452170E 01	0.1054770E 01	0.1800000E 01
0.6388689E 01	0.2299831E 01	0.6976104E 00	0.1900000E 01
0.5513454E 01	0.2158225E 01	0.3670989E-00	0.2000000E 01
0.4737269E 01	0.2026772E 01	0.6193516E 01	0.2100000E 01
0.4047202E 01	0.1904851E 01	-0.2194774E-00	0.2200000E 01
0.3431709E 01	0.1791827E 01	-0.4787655E 00	0.2300000E 01
0.2880592E 01	0.1687073E	-0.7175394E 00	0.2400000E 01
0.2304910E 01	0.1589978E 01	-0.9173602E 00	0.2500000E 01
0.1936873E 01	0.1499950E 01	-0.1139719E 01	0.2600000E 01
0.1529717E 01	0.1416464E 01	-0.1326024E 01	0.2700000E 01
0.1157592E 01	0.1338979E 01	0.149[illegible]594E 01	0.2800000E 01
0.8154415E 00	0.1267022E 01	0.1655656E 01	0.2900000E 01
0.4989065E 00	0.1200149E 01	-0.1801344E 01	0.3000000E 01

$\overline{T}_D$ = -0.4000000E 01 $\overline{W}$ = 0.2100000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.5153333E 02	0.6375000E 01	0.1050000E 02	0.
0.5551355E 02	0.6619042E 01	0.1109571E 02	-0.3000000E-00
0.5694039E 02	0.6822027E 01	0.1159152E 02	-0.4000000E-00
0.6382609E 02	0.7131862E 01	0.1227547E 02	-0.5000000E 00
0.7066531E 02	0.7476382E 01	0.1319150E 02	-0.6000000E 00
0.8026096E 02	0.7972780E 01	0.1440666E 02	-0.7000000E 00
0.9397036E 02	0.8633394E 01	0.1602537E 02	-0.8000000E 00
0.1142175E 03	0.9526770E 01	0.1821668E 02	-0.9000000E 00
0.1456733E 03	0.1077039E 02	0.2127039E 02	[illegible].1000000E 01
0.1983270E 03	0.1258746E 02	0.2572477E 02	-0.1100000E 01
0.2969416E 03	0.1541747E 02	0.3270116E 02	-0.1200000E 01
0.5184036E 03	0.2040235E 02	0.4427997E 02	0.1300000E 01
0.1216394E 04	0.3130462E 0[illegible]	0.7185706E 02	0.1400000E 01
[illegible].2351535E 04	[illegible]	0.1020931E 03	-0.1450000E 01
0.6625037E 04	0.7318123E 02	[illegible]	0.1500000E 01
0.74[illegible]2101E 05	0.2453504E 03	0.5997544E 03	0.1550000E 01
TENSILE END LOADS			
0.4798310E 02	0.6148161E 01	0.9466665E 01	0.3000000E 00
0.4543192E 02	0.5982492E 01	0.95424[illegible] 01	0.4000000E-00
0.4266270E 02	0.5782043E 01	0.9054489E 01	0.5000000E 00
0.3920966E 02	0.5554411E 01	0.8530412E 01	0.6000000E 00
0.3581968E 02	0.5307256E 01	[illegible]	0.7000000E 00
0.3242122E 02	0.5047813E 01	0.7269326E 01	0.8000000E 00
0.2911535E 02	0.4782555E 01	0.6626132E 01	0.9000000E 00
0.2597563E 02	0.4516923E 01	0.5983027E 01	0.1000000E 01
0.2305003E 02	0.4255337E 01	0.5351063E 01	0.1100000E 01
0.2036489E 02	0.4001177E 01	0.4736305E 01	0.1200000E 01
0.1772950E 02	0.3756897E 01	0.4150844E 01	0.1300000E 01
0.1576077E 02	0.3524150E 01	0.3592657E 01	0.1400000E 01
0.1378710E 02	0.3303931E 01	0.3066154E 01	0.1500000E 01
0.1205204E 02	0.3096717E 01	0.2572604E 01	0.1600000E 01
0.1051597E 02	0.2902504E 01	0.2111531E 01	0.1700000E 01
0.9158706E 01	0.2721318E 01	0.1682929E 01	0.1800000E 01
0.7960220E 01	0.2552497E 01	0.1285484E 01	0.1900000E 01
0.6901535E 01	0.2395563E 01	0.9177472E 00	0.2000000E 01
0.5965132E 01	0.2249073E 01	0.5780613E 00	0.2100000E 01
0.5135141E 01	0.2114739E 01	0.2646640E-00	0.2200000E 01
0.4397400E 01	0.1989460E 01	0.2424124E-01	0.2300000E 01
0.3739525E 01	0.1873339E 01	-0.2904326E-00	0.2400000E 01
0.3150155E 01	0.1765701E 01	-0.5356344E 00	0.2500000E 01
0.2620121E 01	0.1665901E 01	0.7614937E 00	0.2600000E 01
0.2140997E 01	0.1573329E 01	0.9695667E 00	0.2700000E 01
0.1705600E 01	0.1487412E 01	0.1161308E 01	0.2800000E 01
0.1307772E 01	0.1407419E 01	0.1348075E 01	0.2900000E 01
0.9420344E 00	0.1333458E 01	0.1501120E 01	0.3000000E 01

$\overline{T}_D$ = 0.4000000E 01 $\overline{W}$ = 0.2400000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.6201905E 02	0.7000000E 01	0.1200000E 02	0.
0.6680709E 02	0.7261784E 01	0.1265410E 02	0.3000000E 00
0.7093000E 02	0.7492515E 01	0.1319948E 02	0.4000000E-00
0.7680839E 02	0.7797571E 01	0.1394919E 02	0.5000000E 00
0.8503764E 02	0.8208518E 01	0.1495507E 02	0.6000000E 00
0.9658428E 02	0.8755196E 01	0.1628907E 02	0.7000000E 00
0.1130825E 03	0.9570054E 01	0.1806595E 02	0.8000000E 00
0.1374507E 03	0.1045850E 02	0.2017122E 02	0.9000000E 00
0.1755102E 03	0.1182204E 02	0.2302204E 02	0.1000000E 01
0.2366879E 03	0.1381107E 02	0.2871140E 02	0.1100000E 01
0.3573930E 03	0.1622167E 02	0.3636721E 02	0.1200000E 01
0.6739824E 03	0.2257108E 02	0.4984022E 02	0.1300000E 01
0.1464227E 04	0.3535296E 02	0.7933179E 02	0.1400000E 01
0.2030715E 04	0.4780360E 02	0.1125072E 03	0.1450000E 01
0.7973998E 04	0.8019355E 02	0.1926735E 03	0.1500000E 01
0.8946830E 05	0.2672005E 03	0.6567565E 03	0.155[illegible]E 01
TENSILE END LOADS			
0.5775000E 02	0.6751091E 01	0.1139240E 02	0.3000000E 00
0.5467973E 02	0.6569302E 01	0.1074091E 02	0.4000000E-00
0.5110851E 02	0.6349350E 01	0.1051768E 02	0.5000000E 00
0.4739645E 02	0.6099565E 01	0.9804156E 01	0.6000000E 00
0.4117009E 02	0.5878357E 01	0.9164105E 01	0.7000000E 00
0.3905429E 02	0.5541668E 01	0.8452052E 01	0.8000000E 00
0.3506084E 02	0.5292578E 01	0.7765411E 01	0.9000000E 00
0.3128769E 02	0.4901085E 01	0.7058915E 01	0.1000000E 01
0.2777321E 02	0.4675025E 01	0.6544429E 01	0.1100000E 01
0.2454889E 02	0.4395110E 01	0.5671042E 01	0.1200000E 01
0.2162593E 02	0.4127030E 01	0.5025120E 01	0.1300000E 01
0.1900058E 02	0.3871600E 01	0.4411663E 01	0.1400000E 01
0.1665099E 02	0.3629914E 01	0.3832491E 01	0.1500000E 01
0.1458108E 02	0.3402491E 01	0.3289617E 01	0.1600000E 01
0.1274347E 02	0.3189473E 01	0.2782549E 01	0.1700000E 01
0.1112180E 02	0.2990467E 01	0.2310807E 01	0.1800000E 01
0.9691961E 01	0.2805164E 01	0.1873356E 01	0.1900000E 01
0.8431097E 01	0.2632901E 01	0.1468390E 01	0.2000000E 01
0.7318118E 01	0.2472973E 01	0.1094187E 01	0.2100000E 01
0.6353722E 01	0.2324427E 01	0.7480544E 00	0.2200000E 01
0.5461458E 01	0.2187092E 01	0.4102810E 00	0.2300000E 01
0.4685650E 01	0.2059805E 01	0.1136742E 00	0.2400000E 01
0.3995305E 01	0.1941425E 01	-0.1331086E 00	0.2500000E 01
0.3372900E 01	0.1831844E 01	-0.3832683E-00	0.2600000E 01
0.2814672E 01	0.1735193E 01	-0.6111080E 00	0.2700000E 01
0.2309346E 01	0.1635095E 01	0.8250221E 00	0.2800000E 01
0.1850074E 01	0.1548716E 01	0.1020494E 01	0.2900000E 01
0.1440204E 01	0.1466784E 01	0.1200096E 01	0.3000000E 01

$\overline{T}_D$ = 0.8000000E 01 $\overline{W}$ = 0.

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.2133333E 02	0.4000000E 01	0.	0.
0.2297245E 02	0.4155498E 01	0.3740120E 00	[illegible]
0.2438084E 02	0.4285222E 01	0.6856135E 00	0.4000000E 00
0.2618912E 02	0.4561508E 01	0.1115751E 01	[illegible]
0.2912915E 02	0.4702551E 01	0.1693102E 01	[illegible]
0.3311836E 02	0.5012743E 01	0.2459674E 01	0.7000000E 00
0.3876204E 02	0.5441551E 01	0.3462534E 01	0.8000000E 00
0.4706114E 02	0.6012107E 01	0.4849804E 01	[illegible]
0.5974622E 02	0.6806526E 01	[illegible]	[illegible]
0.8150111E 02	0.7984326E 01	0.7656935E 01	[illegible]
0.1210512E 03	0.9776131E 01	[illegible]	[illegible]
0.2124160E 03	0.1296255E 02	0.2190667E 02	[illegible]
0.4270631E 03	0.1993261E 02	0.3305792E 02	0.1400000E 01
0.9620203E 03	[illegible]	0.5418851E 02	[illegible]
0.2709904E 04	0.4670974E 02	0.1050947E 03	[illegible]
0.3016203E 05	0.1567992E 03	0.3756110E 03	[illegible]
TENSILE END LOADS			
[illegible]	0.3655297E 01	0.3469767E 00	[illegible]
[illegible]	[illegible]	0.5099404E 00	[illegible]
[illegible]	0.3621794E 01	0.7054489E 00	[illegible]
[illegible]	0.3476651E 01	[illegible]	[illegible]
[illegible]	0.3319029E 01	0.1626356E 01	[illegible]
[illegible]	0.3155751E 01	0.2018401E 01	[illegible]
[illegible]	0.2984745E 01	0.2411763E 01	[illegible]
0.1076517E 02	0.2815566E 01	0.2815566E 01	[illegible]
[illegible]	[illegible]	0.3209327E 01	[illegible]
0.8419820E 01	[illegible]	0.3501711E 01	0.1200000E 01
0.7195129E 01	0.2311935E 01	0.3962970E 01	0.1300000E 01
0.6404114E 01	0.2185922E 01	0.4260674E 01	0.1400000E 01
0.5637096E 01	0.2044103E 01	0.4597732E 01	0.1500000E 01
0.4692208E 01	0.1912565E 01	0.4896177E 01	0.1600000E 01
0.4226771E 01	0.1789413E 01	-0.5171461E 01	0.1700000E 01
0.3632276E 01	0.1674556E 01	0.5425561E 01	0.1800000E 01
0.3100697E 01	0.1567684E 01	0.5659746E 01	0.1900000E 01
0.2624237E 01	0.1468396E 01	0.5871502E 01	0.2000000E 01
0.2195777E 01	0.1376317E 01	0.6059665E 01	0.2100000E 01
0.1800851E 01	0.1291044E 01	0.6148651E 01	0.2200000E 01
0.1455767E 01	0.1212255E 01	0.6511822E 01	0.2300000E 01
0.1137115E 01	0.1136951E 01	0.6560160E 01	0.2400000E 01
0.8427672E 00	0.1071269E 01	0.6695430E 01	0.2500000E 01
0.5707070E 00	0.1008651E 01	-0.6818142E 01	0.2600000E 01
0.3175567E 00	0.9505551E 00	0.6929547E 01	0.2700000E 01
0.8038887E-01	0.8967617E 00	0.7030623E 01	0.2800000E 01
-0.1433220E-00	0.8488830E 00	0.7122284E 01	0.2900000E 01
0.3557551E-00	0.8005974E 00	0.7205374E 01	0.3000000E 01

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = -0.8000000E 01 $\overline{W}$ = 0.3000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.2821905E 02	0.4625000E 01	0.1500000E 01	0.
0.3038879E 02	0.4804440E 01	0.1932400E 01	-0.3000000E-00
0.3225344E 02	0.4953710E 01	0.2292593E 01	-0.4000000E-00
0.3491527E 02	0.5159514E 01	0.2789879E 01	-0.5000000E 00
0.3843515E 02	0.5434988E 01	0.3456596E 01	-0.6000000E 00
0.4305467E 02	0.5800159E 01	0.4342078E 01	-0.7000000E 00
0.5130828E 02	0.6286212E 01	0.5523176E 01	-0.8000000E 00
0.6231135E 02	0.6943638E 01	0.7124346E 01	-0.9000000E 00
0.7939848E 02	0.7858973E 01	0.9358973E 01	-0.1000000E 01
0.1079399E 03	0.9192940E 01	0.1262346E 02	-0.1100000E 01
0.1615225E 03	0.1128033E 02	0.1774368E 02	-0.1200000E 01
0.2817156E 03	0.1493125E 02	0.2676763E 02	-0.1300000E 01
0.6604805E 03	0.2298094E 02	0.4654265E 02	-0.1400000E 01
0.1276437E 04	0.3201070E 02	0.6892636E 02	-0.1450000E 01
0.3594757E 04	0.5382686E 02	0.1226104E 03	-0.1500000E 01
0.4032789E 05	0.1806497E 03	0.4355109E 03	-0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.2627285E 02	0.4458227E 01	0.1098760E 01	0.3000000E-00
0.2489364E 02	0.4336438E 01	0.8061699E 00	0.4000000E-00
0.2327348E 02	0.4189102E 01	0.4527245E-00	0.5000000E 00
0.2149737E 02	0.4021806E 01	0.5214980E-01	0.6000000E 00
0.1964557E 02	0.3840196E 01	-0.3816958E-00	0.7000000E 00
0.1778726E 02	0.3649600E 01	-0.8357440E 00	0.8000000E 00
0.1597734E 02	0.3456770E 01	-0.1298364E 01	0.9000000E 00
0.1425576E 02	0.3259729E 01	-0.1759729E 01	0.1000000E 01
0.1264856E 02	0.3067720E 01	-0.2211961E 01	0.1100000E 01
0.1117006E 02	0.2881232E 01	-0.2646973E 01	0.1200000E 01
0.9825346E 01	0.2702080E 01	-0.3066494E 01	0.1300000E 01
0.8612745E 01	0.2531462E 01	-0.3461627E 01	0.1400000E 01
0.7526035E 01	0.2370084E 01	-0.3832693E 01	0.1500000E 01
0.6556189E 01	0.2218344E 01	-0.4178961E 01	0.1600000E 01
0.5692721E 01	0.2076271E 01	-0.4500424E 01	0.1700000E 01
0.4924640E 01	0.1943704E 01	-0.4797603E 01	0.1800000E 01
0.4241128E 01	0.1820330E 01	-0.5071392E 01	0.1900000E 01
0.3631891E 01	0.1705733E 01	-0.5322934E 01	0.2000000E 01
0.3087440E 01	0.1599437E 01	-0.5553510E 01	0.2100000E 01
0.2599209E 01	0.1500932E 01	-0.5764510E 01	0.2200000E 01
0.2159505E 01	0.1409497E 01	-0.5957290E 01	0.2300000E 01
0.1763564E 01	0.1325218E 01	-0.6133254E 01	0.2400000E 01
0.1399447E 01	0.1246993E 01	-0.6293704E 01	0.2500000E 01
0.1067981E 01	0.1174554E 01	-0.6439917E 01	0.2600000E 01
0.7626764E 00	0.1107420E 01	-0.6573088E 01	0.2700000E 01
0.4796470E-00	0.1045196E 01	-0.6694337E 01	0.2800000E 01
0.2155370E-00	0.9874798E 00	-0.6804705E 01	0.2900000E 01
-0.3254837E-01	0.9339050E 00	-0.6905352E 01	0.3000000E 01

$\overline{T}_D$ = -0.8000000E 01 $\overline{W}$ = 0.6000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.3607619E 02	0.5750000E 01	0.3000000E 01	0.
0.3885130E 02	0.5453182E 01	0.3490786E 01	-0.3000000E-00
0.4123682E 02	0.5622198E 01	0.3899552E 01	-0.4000000E-00
0.4463997E 02	0.5855223E 01	0.4463806E 01	-0.5000000E 00
0.4940280E 02	0.6167125E 01	0.5220165E 01	-0.6000000E 00
0.5608341E 02	0.6580574E 01	0.6224481E 01	-0.7000000E 00
0.6562543E 02	0.7130012E 01	0.7563758E 01	-0.8000000E 00
0.7971415E 02	0.7875168E 01	0.9378886E 01	-0.9000000E 00
0.1015971E 03	0.8911420E 01	0.1191142E 02	-0.1000000E 01
0.1382190E 03	0.1042155E 02	0.1561008E 02	-0.1100000E 01
0.2067959E 03	0.1278453E 02	0.2140973E 02	-0.1200000E 01
0.3607817E 03	0.1693998E 02	0.3162857E 02	-0.1300000E 01
0.8460659E 03	0.2602927E 02	0.5401738E 02	-0.1400000E 01
0.1635262E 04	0.3623054E 02	0.7921675E 02	-0.1450000E 01
0.4605642E 04	0.6094499E 02	0.1401262E 03	-0.1500000E 01
0.5167059E 05	0.2044998E 03	0.4943107E 03	-0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.3358847E 02	0.5061157E 01	0.2544496E 01	0.3000000E-00
0.3102390E 02	0.4923249E 01	0.2212280E 01	0.4000000E-00
0.2975285E 02	0.4756409E 01	0.1810098E 01	0.5000000E 00
0.2748304E 02	0.4566961E 01	0.1355894E 01	0.6000000E 00
0.2511726E 02	0.4361297E 01	0.8629646E 00	0.7000000E 00
0.2274418E 02	0.4145449E 01	0.3469126E-00	0.8000000E 00
0.2045414E 02	0.3924796E 01	-0.1790846E-00	0.9000000E 00
0.1823083E 02	0.3703891E 01	-0.7036915E 00	0.1000000E 01
0.1619007E 02	0.3486608E 01	-0.1218554E 01	0.1100000E 01
0.1430773E 02	0.3275164E 01	-0.1716236E 01	0.1200000E 01
0.1259781E 02	0.3072200E 01	-0.2192019E 01	0.1300000E 01
0.1105817E 02	0.2878893E 01	-0.2642630E 01	0.1400000E 01
0.9680814E 01	0.2696069E 01	-0.3066154E 01	0.1500000E 01
0.8454176E 01	0.2524120E 01	-0.3461748E 01	0.1600000E 01
0.7364813E 01	0.2363110E 01	-0.3829386E 01	0.1700000E 01
0.6398640E 01	0.2212855E 01	-0.4169644E 01	0.1800000E 01
0.5541770E 01	0.2072997E 01	-0.4483518E 01	0.1900000E 01
0.4781027E 01	0.1943071E 01	-0.4772286E 01	0.2000000E 01
0.4104269E 01	0.1822538E 01	-0.5037397E 01	0.2100000E 01
0.3500428E 01	0.1710920E 01	-0.5280368E 01	0.2200000E 01
0.2959726E 01	0.1607330E 01	-0.5502774E 01	0.2300000E 01
0.2473465E 01	0.1511484E 01	-0.5706147E 01	0.2400000E 01
0.2034041E 01	0.1422717E 01	-0.5891978E 01	0.2500000E 01
0.1634792E 01	0.1340487E 01	-0.6061692E 01	0.2600000E 01
0.1269991E 01	0.1264284E 01	-0.6216630E 01	0.2700000E 01
0.9356457E 00	0.1193629E 01	-0.6358057E 01	0.2800000E 01
0.6244553E 00	0.1128077E 01	-0.6487123E 01	0.2900000E 01
0.3357024E-00	0.1067214E 01	-0.6604928E 01	0.3000000E 01

$\overline{T}_D$ = 0.8000000E 01 $\overline{W}$ = 0.9000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.4490478E 02	0.5675000E 01	0.4500000E 01	0.
0.4836004E 02	0.6101924E 01	0.5049773E 01	0.3000000E 00
0.5151101E 02	0.6290685E 01	0.5506510E 01	-0.4000000E 00
0.5556948E 02	0.6553931E 01	0.6137734E 01	-0.5000000E 00
0.6150207E 02	0.6894261E 01	0.6963736E 01	-0.6000000E 00
0.6982460E 02	0.7360990E 01	0.8105805E 01	-0.7000000E 00
0.8171368E 02	0.7975532E 01	0.9606456E 01	-0.8000000E 00
0.9926973E 02	0.8806699E 01	0.1161343E 02	-0.9000000E 00
0.1265420E 03	0.9968647E 01	0.1446382E 02	-0.1000000E 01
0.1772085E 03	0.1165817E 02	0.1859674E 02	-0.1100000E 01
0.2576735E 03	0.1428673E 02	0.2507317E 02	-0.1200000E 01
0.4496324E 03	0.1892878E 02	0.3648752E 02	-0.1300000E 01
0.1056619E 04	0.2907760E 02	0.6149210E 02	-0.1400000E 01
0.2038495E 04	0.4049311E 02	0.8961970E 02	-0.1450000E 01
0.5761619E 04	0.6800111E 02	0.1574500E 03	-0.1500000E 01
0.6441714E 05	0.2203492E 03	0.5531154E 03	-0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.4180923E 02	0.5666080E 01	0.3902426E 01	0.3000000E-00
0.3761082E 02	0.5510083E 01	0.3616320E 01	0.4000000E-00
0.3703112E 02	0.5322351E 01	0.3162071E 01	0.5000000E 00
0.3420455E 02	0.5112116E 01	0.2659180E 01	0.6000000E 00
0.3126512E 02	0.4891520E 01	0.2107626E 01	0.7000000E 00
0.2831364E 02	0.4661298E 01	0.1524569E 01	[illegible]
0.2544336E 02	0.4437622E 01	0.9407745E 00	[illegible]
0.2272284E 02	0.4188054E 01	0.3519457E 00	[illegible]
0.2016097E 02	[illegible]	[illegible]	[illegible]
0.1783254E 02	0.3692397E 01	0.7836992E 00	0.1200000E 01
0.1571125E 02	0.3462335E 01	0.1317556E 01	0.1300000E 01
0.1380530E 02	0.3226363E 01	0.1823635E 01	0.1400000E 01
0.1210134E 02	0.3022051E 01	0.2299853E 01	0.1500000E 01
0.1058644E 02	0.2829897E 01	0.2744535E 01	0.1600000E 01
0.9241455E 01	0.2649988E 01	0.3155392E 01	0.1700000E 01
0.8054772E 01	0.2482072E 01	0.3544680E 01	0.1800000E 01
[illegible]	0.2325663E 01	0.3903544E 01	0.1900000E 01
[illegible]	0.2180409E 01	0.4221637E 01	0.2000000E 01
0.5246174E 01	0.2045638E 01	0.4521265E 01	0.2100000E 01
0.4512463E 01	0.1920700E 01	0.4773227E 01	0.2200000E 01
0.3858368E 01	0.1804962E 01	0.5048250E 01	0.2300000E 01
0.3272815E 01	0.1697750E 01	0.5279240E 01	0.2400000E 01
0.2746521E 01	0.1598440E 01	0.5490353E 01	0.2500000E 01
0.2271142E 01	0.1506410E 01	0.5683660E 01	0.2600000E 01
0.1839501E 01	0.1421140E 01	0.5860172E 01	0.2700000E 01
0.1445305E 01	0.1342062E 01	0.6021755E 01	0.2800000E 01
0.1083427E 01	0.1268671E 01	0.6169542E 01	0.2900000E 01
0.7489970E 00	0.1200523E 01	0.6104704E 01	0.3000000E 01

$\overline{T}_D$ = 0.8000000E 01 $\overline{W}$ = 0.1200000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.5470476E 02	0.6500000E 01	0.6000000E 01	0.
0.5691513E 02	0.6756668E 01	0.6607556E 01	0.3000000E 00
0.6253602E 02	0.6959771E 01	[illegible]	0.4000000E 00
0.6770179E 02	0.7264640E 01	0.7811651E 01	[illegible]
0.7492977E 02	0.7611398E 01	[illegible]	[illegible]
0.8507813E 02	[illegible]	[illegible]	[illegible]
0.9957241E 02	[illegible]	[illegible]	[illegible]
0.1209754E 03	[illegible]	[illegible]	[illegible]
0.1542353E 03	[illegible]	[illegible]	[illegible]
0.2090970E 03	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.1900000E 01
[illegible]	[illegible]	[illegible]	0.2000000E 01
[illegible]	[illegible]	[illegible]	0.2100000E 01
[illegible]	[illegible]	[illegible]	0.2200000E 01
[illegible]	[illegible]	[illegible]	0.2300000E 01
[illegible]	[illegible]	[illegible]	0.2400000E 01
[illegible]	[illegible]	[illegible]	0.2500000E 01
0.2201186E 01	[illegible]	[illegible]	0.2600000E 01
0.1592455E 01	0.1409270E 01	[illegible]	0.2700000E 01
0.1223356E 01	0.1331613E 01	0.6004430E 01	0.3000000E 01

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = -0.8000000E 01 $\overline{W}$ = 0.1500000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.6547619E 02	0.7125000E 01	0.7500000E 01	0.
0.7051637E 02	0.7399407E 01	0.8165947E 01	-0.3000000E-00
0.7685189E 02	0.7627661E 01	0.8720426E 01	-0.4000000E-00
0.8103691E 02	0.7942348E 01	0.9485587E 01	-0.5000000E 00
0.8969548E 02	0.8363534E 01	0.1051087E 02	-0.6000000E 00
0.1018443E 03	0.8921821E 01	0.1187169E 02	-0.7000000E 00
0.1192023E 03	0.9664851E 01	0.1368550E 02	-0.8000000E 00
0.1448392E 03	0.1066976E 02	0.1514251E 02	-0.9000000E 00
0.1846707E 03	0.1206876E 02	0.1956876E 02	-0.1000000E 01
0.2513473E 03	0.1410739E 02	0.2456995E 02	-0.1100000E 01
0.3762293E 03	0.1729713E 02	0.3240787E 02	-0.1200000E 01
0.6566874E 03	0.2290616E 02	0.4621141E 02	-0.1300000E 01
0.1540630E 04	0.3517427E 02	0.7644156E 02	-0.1400000E 01
0.2978196E 04	0.4896985E 02	0.1104591E 03	-0.1450000E 01
0.8388971E 04	0.8229935E 02	0.1926735E 03	-0.1500000E 01
0.9412175E 05	0.2760500E 03	0.6707102E 03	0.1550000E 01
TENSILE END LOADS			
0.6096612E 02	0.6869946E 01	0.5081705E 01	0.3000000E-00
0.5775477E 02	0.6683683E 01	0.6430611E 01	0.4000000E-00
0.5399637E 02	0.6458328E 01	0.5885418E 01	0.5000000E 00
0.4987909E 02	0.6202426E 01	0.5267127E 01	0.6000000E 00
0.4558973E 02	0.5924600E 01	0.4596946E 01	0.7000000E 00
0.4129015E 02	0.5632996E 01	0.3894862E 01	0.8000000E 00
0.3710845E 02	0.5334873E 01	0.3178753E 01	0.9000000E 00
0.3313779E 02	0.5036390E 01	0.2463670E 01	0.1000000E 01
0.2943897E 02	0.4742475E 01	0.1761606E 01	0.1100000E 01
0.2604553E 02	0.4456962E 01	0.1081975E 01	0.1200000E 01
0.2296872E 02	0.4182399E 01	0.4314080E-00	0.1300000E 01
0.2020520E 02	0.3921245E 01	0.1856392E-00	0.1400000E 01
0.1774019E 02	0.3674017E 01	-0.7665386E 00	0.1500000E 01
0.1555261E 02	0.3441449E 01	-0.1310109E 01	0.1600000E 01
0.1361783E 02	0.3223624E 01	-0.1816274E 01	0.1700000E 01
0.1191049E 02	0.3020299E 01	-0.2285769E 01	0.1800000E 01
0.1040496E 02	0.2830996E 01	-0.2719897E 01	0.1900000E 01
0.9077316E 01	0.2655085E 01	-0.3120340E 01	0.2000000E 01
0.7905396E 01	0.2491040E 01	-0.3489013E 01	0.2100000E 01
0.6869118E 01	0.2340484E 01	-0.3827944E 01	0.2200000E 01
0.5950558E 01	0.2200227E 01	-0.4139201E 01	0.2300000E 01
0.5133883E 01	0.2070282E 01	-0.4424826E 01	0.2400000E 01
0.4405216E 01	0.1949080E 01	-0.4686801E 01	0.2500000E 01
0.3752455E 01	0.1838116E 01	-0.4927016E 01	0.2600000E 01
0.3165106E 01	0.1734077E 01	-0.5147256E 01	0.2700000E 01
0.2634085E 01	0.1638928E 01	-0.5349192E 01	0.2800000E 01
0.2151546E 01	0.1549867E 01	-0.5534380E 01	0.2900000E 01
0.1710718E 01	0.1467140E 01	-0.5704256E 01	0.3000000E 01

$\overline{T}_D$ = -0.8000000E 01 $\overline{W}$ = 0.1800000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.7721905E 02	0.7750000E 01	0.9000000E 01	0.
0.8316389E 02	0.8048150E 01	0.9725334E 01	-0.3000000E-00
0.8827836E 02	0.8296150E 01	0.1032738E 02	-0.4000000E-00
0.9557481E 02	0.8638057E 01	0.1115951E 02	-0.5000000E 00
0.1057896E 03	0.9095671E 01	0.1227444E 02	-0.6000000E 00
0.1201228E 03	0.9702236E 01	0.1375410E 02	-0.7000000E 00
0.1406030E 03	0.1050951E 02	0.1572609E 02	-0.8000000E 00
0.1708532E 03	0.1160129E 02	0.1839705E 02	-0.9000000E 00
0.2178546E 03	0.1312121E 02	0.2212121E 02	-0.1000000E 01
0.2965371E 03	0.1533601E 02	0.2755657E 02	-0.1100000E 01
0.4439114E 03	0.1890133E 02	0.3607392E 02	-0.1200000E 01
0.7748917E 03	0.2489489E 02	0.5107236E 02	-0.1300000E 01
0.1818089E 04	0.3822760E 02	0.8391629E 02	-0.1400000E 01
0.3514659E 04	0.5320961E 02	0.1208732E 03	-0.1450000E 01
0.9900305E 04	0.8941748E 02	0.2101893E 03	-0.1500000E 01
0.1110798E 06	0.2999001E 03	0.7291101E 03	-0.1550000E 01
TENSILE END LOADS			
0.7190236E 02	0.7472879E 01	0.8327441E 01	0.3000000E-00
0.6811170E 02	0.7270496E 01	0.7836721E 01	0.4000000E-00
0.6367736E 02	0.7025655E 01	0.7243591E 01	0.5000000E 00
0.5882414E 02	0.6747581E 01	0.6570071E 01	0.6000000E 00
0.5376635E 02	0.6445702E 01	0.5841603E 01	0.7000000E 00
0.4869721E 02	0.6128845E 01	0.5077539E 01	0.8000000E 00
0.4376785E 02	0.5804899E 01	0.4298032E 01	0.9000000E 00
0.3908822E 02	0.5480543E 01	0.3519457E 01	0.1000000E 01
0.3473007E 02	0.5161163E 01	0.2754992E 01	0.1100000E 01
0.3071275E 02	0.4850894E 01	0.2014712E 01	0.1200000E 01
0.2711191E 02	0.4552732E 01	0.1305884E 01	0.1300000E 01
0.2385779E 02	0.4268857E 01	0.6333577E 00	0.1400000E 01
0.2095033E 02	0.4000000E 01	-0.	0.1500000E 01
0.1836691E 02	0.3747275E 01	-0.5929961E 00	0.1600000E 01
0.1611459E 02	0.3510365E 01	-0.1145237E 01	0.1700000E 01
0.1411106E 02	0.3289448E 01	-0.1657810E 01	0.1800000E 01
0.1236466E 02	0.3083663E 01	-0.2132023E 01	0.1900000E 01
0.1079237E 02	0.2892423E 01	-0.2569692E 01	0.2000000E 01
0.9422691E 01	0.2714940E 01	-0.2972887E 01	0.2100000E 01
0.8211696E 01	0.2550373E 01	-0.3343803E 01	0.2200000E 01
0.7144226E 01	0.2397860E 01	-0.3684677E 01	0.2300000E 01
0.6195594E 01	0.2256549E 01	-0.3997720E 01	0.2400000E 01
0.5351417E 01	0.2125612E 01	-0.4285075E 01	0.2500000E 01
0.4597417E 01	0.2004159E 01	-0.4554793E 01	0.2600000E 01
0.3921201E 01	0.1891742E 01	-0.4790731E 01	0.2700000E 01
0.3312047E 01	0.1787360E 01	-0.501[illegible]E 01	0.2800000E 01
0.2760691E 01	0.1690464E 01	-0.521[illegible]E 01	0.2900000E 01
0.2259144E 01	0.1600446E 01	-0.540[illegible]E 01	0.3000000E 01

$\overline{T}_D$ = -0.8000000E 01 $\overline{W}$ = 0.2100000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.8993333E 02	0.8375000E 01	0.1050000E 02	0.
0.9605743E 02	0.8696092E 01	0.1128272E 02	0.3000000E 00
0.1028160E 03	0.8969630E 01	0.1193434E 02	0.4000000E 00
0.1113156E 03	0.9333765E 01	0.1283344E 02	-0.5000000E 00
0.1232154E 03	0.9827800E 01	0.1403803E 02	-0.6000000E 00
0.1399139E 03	0.1048265E 02	0.1563650E 02	0.7000000E 00
0.1637747E 03	0.1135417E 02	0.1776667E 02	0.8000000E 00
0.1990199E 03	0.1255282E 02	0.[illegible]65159E 02	0.9000000E 00
0.2537040E 03	0.1417366E 02	0.2467366E 02	-0.1000000E 01
0.3658671E 03	0.1658462E 02	0.3054119E 02	-0.1100000E 01
0.5171957E 03	0.2010554E 02	0.3973297E 02	-0.1200000E 01
0.9020005E 03	0.2698161E 02	0.5591331E 02	0.1300000E 01
0.2110511E 04	0.4127023E 02	0.9132132E 02	0.1400000E 01
0.4095532E 04	0.5746940E 02	0.1312074E 03	0.1450000E 01
0.1153675E 05	0.9675560E 02	0.2277051E 03	0.1500000E 01
0.1294417E 06	0.3237502E 03	0.[illegible]3099E 03	0.1550000E 01
TENSILE END LOADS			
0.8376357E 02	0.8075910E 01	0.9775117E 01	0.3000000E 00
0.7932544E 02	0.7857726E 01	0.9242933E 01	0.4000000E 00
0.7416326E 02	0.7592546E 01	0.8601785E 01	0.5000000E 00
0.6850901E 02	0.7292236E 01	0.7876015E 01	0.6000000E 00
0.6261921E 02	0.6966063E 01	0.7048267E 01	0.7000000E 00
0.5671680E 02	0.6625499E 01	0.6264196E 01	0.8000000E 00
0.5097709E 02	0.6274925E 01	0.5417331E 01	0.9000000E 00
0.4551062E 02	0.5924720E 01	0.4575295E 01	0.1000000E 01
0.4045854E 02	0.5577245E 01	0.3746379E 01	0.1100000E 01
0.3580750E 02	0.5244027E 01	0.2947456E 01	0.1200000E 01
0.3159392E 02	0.4922[illegible]E 01	0.2180355E 01	0.1300000E 01
0.2781218E 02	0.4516146E 01	0.1452355E 01	0.1400000E 01
0.2444231E 02	0.4325785E 01	0.7665310E 00	0.1500000E 01
0.2145529E 02	0.4053001E 01	0.1243170E 00	0.1600000E 01
0.1881730E 02	0.3797301E 01	-0.4761996E 00	0.1700000E 01
0.1649328E 02	0.3558596E 01	0.1027852E 01	0.1800000E 01
0.1444831E 02	0.3336329E 01	-0.1554189E 01	0.1900000E 01
0.1264091E 02	0.3129751E 01	-0.2019044E 01	0.2000000E 01
0.1106571E 02	0.2938061E 01	0.2458761E 01	0.2100000E 01
0.9559113E 01	0.2760261E 01	0.2859663E 01	0.2200000E 01
0.8436256E 01	0.2595492E 01	-0.3230157E 01	0.2300000E 01
0.7344758E 01	0.2442015E 01	-0.3570613E 01	0.2400000E 01
0.6375526E 01	0.2301136E 01	0.3883749E 01	0.2500000E 01
0.5511215E 01	0.2170202E 01	0.4120565E 01	0.2600000E 01
0.4739492E 01	0.2048605E 01	-0.4434339E 01	0.2700000E 01
0.4045768E 01	0.1935793E 01	0.4676620E 01	0.2800000E 01
0.3418094E 01	0.1831060E 01	-0.4899215E 01	0.2900000E 01
0.2852615E 01	0.1733756E 01	-0.5103800E 01	0.3000000E 01

$\overline{T}_D$ = -0.8000000E 01 $\overline{W}$ = 0.2400000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1050190E 03	0.9000000E 01	0.1200000E 02	0.
0.1115975E 03	0.9345672E 01	0.1264111E 02	0.3000000E-00
0.1184663E 03	0.9631125E 01	0.1355413E 02	-0.4000000E 00
0.1282591E 03	0.100[illegible]E 02	0.1450737E 02	-0.5000000E 00
0.1419720E 03	0.1055579E 02	0.1580158E 02	-0.6000000E 00
0.1612171E 03	0.1126101E 02	0.1751890E 02	-0.7000000E 00
0.1887117E 03	0.1215061E 02	0.1980725E 02	-0.8000000E 00
0.2293394E 03	0.1346435E 02	0.2290061E 02	0.9000000E 00
0.2924813E 03	0.1572610E 02	0.2727610E 02	-0.1000000E 01
0.3981574E 03	0.1779324E 02	0.3552981E 02	-0.1100000E 01
0.5960822E 03	0.2330274E 02	0.4840025E 02	0.1200000E 01
0.1392656E 04	0.3807234E 02	0.6079426E 02	-0.1300000E 01
0.2441907E 04	0.4412976E 02	0.9848525E 02	-0.1400000E 01
0.4722813E 04	0.6126917E 02	0.1412015E 03	-0.1450000E 01
0.1329831E 05	0.1036537E 03	0.2452209E 03	0.1500000E 01
0.1492075E 06	0.3476203E 03	0.8471978E 03	0.1550000E 01
TENSILE END LOADS			
0.9864010E 02	0.8678740E 01	0.[illegible]21491E 02	0.3000000E 00
0.9134541E 02	0.8444114E 01	0.1068898E 02	0.4000000E 00
0.8544907E 02	0.8150760E 01	0.9959238E 01	0.5000000E 00
0.7893370E 02	0.7837491E 01	0.9170559E 01	0.6000000E 00
0.7214828E 02	0.7487995E 01	0.8330227E 01	0.7000000E 00
0.6534689E 02	0.7120546E 01	0.7442952E 01	0.8000000E 00
0.5873959E 02	0.6744951E 01	0.6535450E 01	0.9000000E 00
0.5240479E 02	0.6370760E 01	0.5651113E 01	0.1000000E 01
0.4662445E 02	0.5990551E 01	0.4741760E 01	0.1100000E 01
0.4124925E 02	0.5635759E 01	0.3886197E 01	0.1200000E 01
0.3641905E 02	0.5292992E 01	0.3054415E 01	0.1300000E 01
0.3206018E 02	0.4963590E 01	0.2271152E 01	0.1400000E 01
0.2819223E 02	0.4651366E 01	0.1531177E 01	0.1500000E 01
0.2475775E 02	0.4355877E 01	0.8415100E 00	0.1600000E 01
0.2172617E 02	0.4086235E 01	0.1960177E 00	0.1700000E 01
0.1905714E 02	0.3827745E 01	-0.[illegible]4214E 00	0.1800000E 01
0.1671004E 02	0.3588714E 01	-0.9582140E 00	0.1900000E 01
0.1464692E 02	0.3367099E 01	-0.[illegible]6939E 01	0.2000000E 01
0.1283269E 02	0.3161142E 01	0.1996354E 01	0.2100000E 01
0.1123537E 02	0.2970149E 01	0.2375120E 01	0.2200000E 01
0.9826948E 01	0.2791175E 01	-0.2775629E 01	0.2300000E 01
0.8501375E 01	0.2629051E 01	-0.3143506E 01	0.2400000E 01
0.7475537E 01	0.2477060E 01	-0.3481674E 01	0.2500000E 01
0.6495957E 01	0.2338145E 01	-0.3792380E 01	0.2600000E 01
0.5619977E 01	0.2205471E 01	0.4077801E 01	0.2700000E 01
0.4825191E 01	0.2086224E 01	-0.4340334E 01	0.2800000E 01
0.4[illegible]E 01	0.1971657E 01	-0.4581637E 01	0.2900000E 01
0.3491129E 01	0.1867045E 01	-0.[illegible]805586E 01	0.3000000E 01

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = -0.1200000E 02 $\overline{W}$ = 0.

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.4800000E 02	0.6000000E 01	0.	0.
0.5166948E 02	0.6233547E 01	0.5610192E 00	-0.3000000E-00
0.5482365E 02	0.6427832E 01	0.1020453E 01	-0.4000000E-00
0.5932400E 02	0.6695738E 01	0.1673927E 01	-0.5000000E 00
0.6562303E 02	0.7054277E 01	0.2539540E 01	-0.6000000E 00
0.7445922E 02	0.7529614E 01	0.3689511E 01	-0.7000000E 00
0.8708125E 02	0.8162329E 01	0.5275890E 01	-0.8000000E 00
0.1057193E 03	0.9018360E 01	0.7304719E 01	-0.9000000E 00
0.1346707E 03	0.1022979E 02	0.1020979E 02	-0.1000000E 01
0.1831254E 03	0.1194649E 02	0.1445525E 02	-0.1100000E 01
0.2738652E 03	0.1466420E 02	0.2111644E 02	-0.1200000E 01
0.4773244E 03	0.1944379E 02	0.3286001E 02	-0.1300000E 01
0.1119784E 04	0.2989892E 02	0.5860188E 02	-0.1400000E 01
0.2164108E 04	0.4165649E 02	0.8758278E 02	-0.1450000E 01
0.6094746E 04	0.7006311E 02	0.1576420E 03	-0.1500000E 01
0.6837483E 05	0.2351994E 03	0.5650665E 03	-0.1550000E 01
TENSILE END LOADS			
0.4470907E 02	0.5782945E 01	-0.5204650E 00	0.3000000E-00
0.4237845E 02	0.5624441E 01	-0.8999105E 00	0.4000000E-00
0.3964086E 02	0.5432693E 01	-0.1358173E 01	0.5000000E 00
0.3664097E 02	0.5214977E 01	-0.1877392E 01	0.6000000E 00
0.3351485E 02	0.4978647E 01	-0.2439534E 01	0.7000000E 00
0.3037980E 02	0.4730626E 01	-0.3027601E 01	0.8000000E 00
0.2732892E 02	0.4477116E 01	-0.3626464E 01	0.9000000E 00
0.2442996E 02	0.4223349E 01	-0.4223349E 01	0.1000000E 01
0.2172710E 02	0.3973547E 01	-0.4807991E 01	0.1100000E 01
0.1924468E 02	0.3710949E 01	-0.5372566E 01	0.1200000E 01
0.1699112E 02	0.3497902E 01	-0.5911655E 01	0.1300000E 01
0.1476304E 02	0.3275908E 01	-0.6420936E 01	0.1400000E 01
0.1315222E 02	0.3066154E 01	-0.6098848E 01	0.1500000E 01
0.1154098E 02	0.2868852E 01	-0.7344261E 01	0.1600000E 01
0.1011233E 02	0.2674149E 01	-0.7757192E 01	0.1700000E 01
0.8847665E 01	0.2511134E 01	-0.8138341E 01	0.1800000E 01
0.7728652E 01	0.2351496E 01	-0.8488099E 01	0.1900000E 01
0.6737866E 01	0.2202593E 01	-0.8810373E 01	0.2000000E 01
0.5959236E 01	0.2064505E 01	-0.9104466E 01	0.2100000E 01
0.5028207E 01	0.1936565E 01	-0.9372977E 01	0.2200000E 01
0.4381739E 01	0.1818607E 01	-0.9617734E 01	0.2300000E 01
0.3759109E 01	0.1709427E 01	-0.9840585E 01	0.2400000E 01
0.3198310E 01	0.1606903E 01	-0.1004311E 02	0.2500000E 01
0.2694264E 01	0.1512901E 01	-0.1022721E 02	0.2600000E 01
0.2233253E 01	0.1425813E 01	-0.1039432E 02	0.2700000E 01
0.1814208E 01	0.1345165E 01	-0.1054593E 02	0.2800000E 01
0.1429609E 01	0.1270324E 01	-0.1068343E 02	0.2900000E 01
0.1074555E 01	0.1200896E 01	-0.1080806E 02	0.3000000E 01

$\overline{T}_D$ = -0.1200000E 02 $\overline{W}$ = 0.3000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.5808571E 02	0.6625000E 01	0.1500000E 01	0.
0.6253227E 02	0.6882289E 01	0.2119406E 01	-0.3000000E-00
0.6635479E 02	0.7096320E 01	0.2635413E 01	-0.4000000E-00
0.7180914E 02	0.7391417E 01	0.3347854E 01	-0.5000000E 00
0.7944416E 02	0.7786413E 01	0.4303109E 01	-0.6000000E 00
0.9015558E 02	0.8310039E 01	0.5571915E 01	-0.7000000E 00
0.1054579E 03	0.9006988E 01	0.7264473E 01	-0.8000000E 00
0.1280561E 03	0.9949691E 01	0.9559250E 01	-0.9000000E 00
0.1631625E 03	0.1126224E 02	0.1276234E 02	-0.1000000E 01
0.2219236E 03	0.1317510E 02	0.1744187E 02	-0.1100000E 01
0.3319716E 03	0.1616840E 02	0.2478249E 02	-0.1200000E 01
0.5791606E 03	0.2143257E 02	0.3772096E 02	-0.1300000E 01
0.1357968E 04	0.3294725E 02	0.6607661E 02	-0.1400000E 01
0.2624630E 04	0.4589626E 02	0.9799688E 02	-0.1450000E 01
0.7392127E 04	0.7718123E 02	0.1751578E 03	-0.1500000E 01
0.8293215E 05	0.2590495E 03	0.6238663E 03	-0.1550000E 01
TENSILE END LOADS			
0.5409852E 02	0.6385075E 01	0.9252712E 00	0.3000000E-00
0.5127466E 02	0.6211252E 01	0.5061997E 00	0.4000000E-00
0.4795853E 02	0.6000000E 01	-0.	0.5000000E 00
0.4432475E 02	0.5760132E 01	-0.5736475E 00	0.6000000E 00
0.4053897E 02	0.5499743E 01	-0.1196874E 01	0.7000000E 00
0.3674324E 02	0.5226475E 01	-0.1844744E 01	0.8000000E 00
0.3305049E 02	0.4947142E 01	-0.2507195E 01	0.9000000E 00
0.2954285E 02	0.4667512E 01	-0.3167512E 01	0.1000000E 01
0.2627391E 02	0.4392235E 01	-0.3814605E 01	0.1100000E 01
0.2327331E 02	0.4125881E 01	-0.4439829E 01	0.1200000E 01
0.2055089E 02	0.3868075E 01	-0.5036779E 01	0.1300000E 01
0.1810384E 02	0.3623438E 01	-0.5601939E 01	0.1400000E 01
0.1591916E 02	0.3392113E 01	-0.6132109E 01	0.1500000E 01
0.1397831E 02	0.3174620E 01	-0.6627268E 01	0.1600000E 01
0.1225971E 02	0.2970998E 01	-0.7086154E 01	0.1700000E 01
0.1074070E 02	0.2780282E 01	-0.7510481E 01	0.1800000E 01
0.9389216E 01	0.2604142E 01	-0.7901025E 01	0.1900000E 01
0.8213978E 01	0.2439931E 01	-0.8259725E 01	0.2000000E 01
0.7165470E 01	0.2287605E 01	-0.8588160E 01	0.2100000E 01
0.6236061E 01	0.2144454E 01	-0.8888455E 01	0.2200000E 01
0.5639986E 01	[illegible]	-0.9163209E 01	0.2300000E 01
0.4673319E 01	[illegible]	-0.9413454E 01	0.2400000E 01
0.4013853E 01	0.1782627E 01	-0.9641619E 01	0.2500000E 01
0.3420951E 01	0.1678844E 01	-0.9848288E 01	0.2600000E 01
0.2885381E 01	0.1582697E 01	-0.1003486E 02	0.2700000E 01
0.2399169E 01	0.1493570E 01	-0.1021965E 02	0.2800000E 01
0.1955301E 01	0.1410923E 01	-0.1036585E 02	0.2900000E 01
0.1568100E 01	0.1334205E 01	-0.1050784E 02	0.3000000E 01

$\overline{T}_D$ = -0.1200000E 02 $\overline{W}$ = 0.6000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.6914256E 02	0.7250000E 01	0.3000000E 01	0.
0.7444333E 02	0.7531011E 01	0.3677793E 01	-0.3000000E 00
0.7899675E 02	0.7764808E 01	0.4242369E 01	-0.4000000E 00
0.8549739E 02	0.8087125E 01	0.5021781E 01	-0.5000000E 00
0.9459692E 02	0.8518550E 01	0.6066678E 01	-0.6000000E 00
0.1073644E 03	0.9090546E 01	0.7455318E 01	-0.7000000E 00
0.1256054E 03	0.9851640E 01	0.9305055E 01	-0.8000000E 00
0.1525457E 03	0.1088172E 02	0.1181379E 02	-0.9000000E 00
0.1944006E 03	0.1225146E 02	0.1531468E 02	-0.1000000E 01
0.2644620E 03	0.1440372E 02	0.2042850E 02	-0.1100000E 01
0.3956801E 03	0.1767280E 02	0.2844854E 02	-0.1200000E 01
0.6901616E 03	0.2342125E 02	0.4250192E 02	-0.1300000E 01
0.1619122E 04	0.3599558E 02	0.7355134E 02	-0.1400000E 01
0.3112956E 04	0.5013631E 02	0.1086113E 03	-0.1450000E 01
0.8811852E 04	0.8429979E 02	[illegible]	-0.1500000E 01
0.9883111E 05	0.2828994E 03	0.6816662E 03	-0.1550000E 01
TENSILE END LOADS			
0.6452111E 02	0.6939776E 01	0.2371007E 01	[illegible]
0.6102754E 02	0.6799063E 01	0.1912310E 01	[illegible]
0.5726783E 02	0.6567357E 01	0.1354937E 01	[illegible]
0.5274818E 02	0.6305287E 01	0.7300260E 00	[illegible]
[illegible]	0.6070844E 01	[illegible]	[illegible]
0.4373923E 02	0.5722335E 01	0.6822377E 00	[illegible]
0.3932271E 02	0.5417736E 01	0.1387236E 01	[illegible]
0.3516773E 02	0.5111678E 01	0.2111678E 01	0.1000000E 01
0.3125913E 02	[illegible]	0.2871219E 01	0.1100000E 01
0.2789094E 02	[illegible]	0.3507092E 01	0.1200000E 01
0.2465242E 02	0.4238164E 01	0.4162525E 01	0.1300000E 01
0.2159563E 02	0.3971489E 01	0.4782742E 01	0.1400000E 01
[illegible]	0.3718120E 01	0.5365771E 01	0.1500000E 01
0.1668971E 02	0.3480494E 01	0.5909335E 01	0.1600000E 01
0.1461132E 02	0.3257026E 01	0.6415117E 01	0.1700000E 01
0.1281554E 02	0.3050131E 01	0.6882424E 01	0.1800000E 01
0.1123005E 02	0.2855829E 01	0.7311151E 01	0.1900000E 01
0.9831570E 01	0.2677269E 01	0.7709077E 01	0.2000000E 01
0.8596822E 01	0.2513706E 01	0.8072213E 01	0.2100000E 01
0.7508756E 01	0.2356342E 01	0.8404694E 01	0.2200000E 01
0.6536545E 01	0.2213362E 01	-0.8708605E 01	0.2300000E 01
0.5675584E 01	0.2080960E 01	-0.5986327E 01	0.2400000E 01
0.4901301E 01	0.1958351E 01	0.9232694E 01	0.2500000E 01
0.4219015E 01	0.1844187E 01	0.9570763E 01	0.2600000E 01
0.3597039E 01	0.1739561E 01	0.9501403E 01	0.2700000E 01
0.3039851E 01	0.1662011E 01	0.9973553E 01	0.2800000E 01
0.2531216E 01	0.1555151E 01	0.1009482E 02	0.2900000E 01
0.2066893E 01	0.1467515E 01	0.1020152E 02	0.3000000E 01

$\overline{T}_D$ = -0.1200000E 02 $\overline{W}$ = 0.9000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.8117143E 02	0.7875000E 01	0.4500000E 01	0.
0.8739666E 02	0.8179773E 01	0.5216180E 01	[illegible]
0.9276951E 02	0.8413296E 01	0.5862327E 01	[illegible]
0.1003878E 03	0.8782834E 01	0.6695708E 01	[illegible]
[illegible]	0.9250687E 01	0.7810207E 01	[illegible]
[illegible]	0.9870061E 01	0.9316722E 01	[illegible]
0.1475214E 03	0.1062631E 02	0.1135584E 02	[illegible]
0.1791861E 03	0.1181275E 02	0.1405813E 02	[illegible]
0.2283851E 03	0.1334711E 02	0.1786713E 02	[illegible]
0.3107580E 03	0.1563233E 02	0.2418132E 02	[illegible]
0.4649908E 03	0.1917484E 02	0.3211859E 02	[illegible]
0.8111030E 03	0.2558222E 02	0.4764255E 02	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
0.8804292E 01	0.2556231E 01	[illegible]	[illegible]
0.7761668E 01	0.2410995E 01	[illegible]	[illegible]
[illegible]	0.2267224E 01	0.8552220E 01	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = -0.1200000E 02 $\overline{W}$ = 0.1200000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.9417143E 02	0.8500000E 01	0.6000000E 01	0.
0.1013981E 03	0.8928514E 01	0.6794566E 01	-0.1000000E-00
0.1076113E 03	0.9101784E 01	0.7456285E 01	0.4000000E-00
0.1164814E 03	0.9478542E 01	0.8369636E 01	-0.5000000E 00
0.1288973E 03	0.9982823E 01	0.959[illegible]16E 01	-0.6000000E 00
0.1463193E 03	0.1065129E 02	0.112[illegible]E 02	0.7000000E 00
0.1712132E 03	0.1154297E 02	0.1338622E 02	-0.8000000E 00
0.2079833E 03	0.1274478E 02	0.1632287E 02	-0.[illegible]000000E 00
0.2651150E 03	0.1441959E 02	0.2041956E 02	-0.1000000E 01
0.3607594E 03	0.1686094E 02	0.2646017E 02	-0.1100000E 01
0.5399037E 03	0.2068100E 02	0.3578154E 02	-0.1200000E 01
0.9422366E 03	0.2739870E 02	0.5253180E 02	-0.1300000E 01
0.2210329E 04	0.4209224E 02	0.8950079E 02	-0.1400000E 01
0.4272553E 04	0.5861558E 02	0.1292372E 03	-0.1450000E 01
0.1203494E 05	0.7855562E 02	0.2277051E 03	-0.1500000E 01
0.1350272E 06	0.3305[illegible]E 03	0.8002552E 03	-0.1550000E 01
TENSILE END LOADS			
0.8769772E 02	0.8194666E 01	0.5262440E 01	0.3000000E-00
0.8310132E 02	0.7971606E 01	0.4724530E 01	0.4000000E-00
0.7771618E 02	0.7701[illegible]E 01	0.4074520E 01	0.5000000E 00
0.7181515E 02	0.7395597E 01	0.3337545E 01	0.6000000E 00
0.6566675E 02	0.7063046E 01	0.2539107E 01	0.7000000E 00
0.5950079E 02	0.6714023E 01	0.1703320E 01	0.8000000E 00
0.5351909E 02	0.6357[illegible]E 01	0.8506527E 00	0.9000000E 00
0.4781333E 02	0.6000000E 01	0.	0.1000000E 01
0.4253075E 02	0.5648301E 01	0.8344447E 00	0.1100000E 01
0.3768320E 02	0.5306679E 01	-0.1641617E 01	0.1200000E 01
0.3328369E 02	0.4978431E 01	-0.2413553E 01	0.1300000E 01
0.2933459E 02	0.4665790E 01	-0.3144948E 01	0.1400000E 01
0.2581505E 02	0.4370086E 01	-0.3832693E 01	0.1500000E 01
0.2269681E 02	0.4091957E 01	-0.4475409E 01	0.1600000E 01
0.1993[illegible]73E 02	0.3831503E 01	-0.5073042E 01	0.1700000E 01
0.1750999E 02	0.3588428E 01	-0.5626508E 01	0.1800000E 01
0.1537229E 02	0.3362162E 01	-0.6137403E 01	0.1900000E 01
0.1349120E 02	0.3151965E 01	-0.6607[illegible]0E 01	0.2000000E 01
0.1183492E 02	0.2956907E 01	-0.7039967E 01	0.2100000E 01
0.1037467E 02	0.2776118E 01	-0.7436411E 01	0.2200000E 01
0.9084749E 01	0.2608627E 01	0.7799637E 01	0.2300000E 01
0.7942463E 01	0.2453492E 01	-0.8132113E 01	0.2400000E 01
0.6927911E 01	0.2309799E 01	0.8436242E 01	0.2500000E 01
0.6023756E 01	0.2176673E 01	-0.8714312E 01	0.2600000E 01
0.5216946E 01	0.2053290E 01	0.8968487E 01	0.2700000E 01
0.4488460E 01	0.1938876E 01	-0.9200790E 01	0.2800000E 01
0.3833049E 01	0.1832712E 01	-0.9413104E 01	0.2900000E 01
0.3239011E 01	0.1734130E 01	-0.9607169E 01	0.3000000E 01

$\overline{T}_D$ = -0.1200000E 02 $\overline{W}$ = 0.1500000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1091429E 03	0.9125000E 01	0.7500600E 01	0.
0.1164460E 03	0.9477257E [illegible]	0.8352955E 01	-0.3000000E-00
0.[illegible]58?5E 03	0.9770277E 01	0.9263243E 01	0.4000000E 00
0.1337778E 03	0.1017425E 02	0.1004356E 02	-0.5000000E 00
0.1480449E 03	0.1071496E 02	0.1135738E 02	-0.6000000E 00
0.1689654E 03	0.1141169E 02	0.1310153E 02	-0.7000000E 00
0.1966735E 03	0.1238563E 02	0.1542680E 02	-0.8000000E 00
0.2369312E 03	0.1367591E 02	0.1857741E 02	-0.9000000E 00
0.3045929E 03	0.1547202E 02	0.2297202E 02	-0.1000000E 01
0.4145184E 03	0.1808256E 02	0.2938836E 02	-0.1100000E 01
0.6204188E 03	0.2218520E 02	0.3944669E 02	-0.1200000E 01
0.1032851E 04	0.2938742E 02	0.5716475E 02	-0.1300000E 01
0.2540394E 04	0.4514057E 02	0.9597552E 02	-0.1400000E 01
0.4910813E 04	0.6285535E 02	0.1396534E 03	-0.1450000E 01
0.1393277E 05	0.1056537E 03	0.2456209E 03	-0.1500000E 01
0.1551922E 06	0.3544498E 03	0.8590657E 03	-0.1550000E 01
TENSILE END LOADS			
0.1030767E 03	0.8722597E 01	0.6709[illegible] 01	[illegible]
0.9942823E 02	0.8554696E 01	0.6132661E 01	[illegible]
0.9223726E 02	0.8269226E 01	0.5632693E 01	[illegible]
0.8345[illegible]E 02	0.7950752E 01	0.4461329E 01	[illegible]
0.7532781E 02	0.7586160E 01	0.3283768E 01	[illegible]
[illegible]	0.7209971E 01	0.[illegible]885642E 01	[illegible]
0.6194325E 02	0.6327245E 01	0.1269[illegible]E 01	[illegible]
[illegible]	0.6444163E 01	0.1035[illegible]E [illegible]	[illegible]
[illegible]	0.6066920E 01	0.1[illegible]E [illegible]	[illegible]
[illegible]	0.5700611E 01	0.20[illegible]E [illegible]	[illegible]
[illegible]3621244E 02	0.5348566E 01	0.1532277E 01	[illegible]
[illegible]3340176E 02	0.5013240E [illegible]	[illegible]2325251E 01	[illegible]
[illegible]	0.4626369E [illegible]	[illegible]3768156E 01	[illegible]
[illegible]	0.4132773E 01	0.3750126E 01	[illegible]
0.2291069E 02	0.4112[illegible]E [illegible]	0.4402035E 01	[illegible]
[illegible]2129681E 02	[illegible]	[illegible]4997849E 01	[illegible]
0.1768373E 02	0.3614428E [illegible]	[illegible]5542529E 01	[illegible]
0.1555323E 02	0.3382283E 01	0.6057132E 01	[illegible]
0.1366165E 02	0.3140008E 01	0.6521[illegible]E 01	[illegible]1100200E 01
0.1127560E [illegible]	0.2986[illegible]E 01	0.6752270E 01	[illegible]
0.1050357E 02	0.2806259E 01	0.7145112E 01	[illegible]
0.9207362E 01	0.2637750E 01	0.7705307E 01	[illegible]
0.8055074E 01	0.2485522E 01	0.8034516E 01	0.25[illegible]E 01
0.7030433E 01	0.2342616E 01	0.8336047E 01	0.25[illegible]E 01
0.6135857E 01	0.2210155E 01	0.8612029E 01	0.27[illegible]E 01
0.5296374E 01	0.2087309E 01	0.8865506E 01	0.28[illegible]E 01
0.4559057E 01	0.1973308E 01	0.9095523E 01	0.29[illegible]E [illegible]
0.3892736E 01	0.1867438E 01	0.9306945E 01	0.30[illegible]E 01

$\overline{T}_D$ = 0.1200000E 02 $\overline{W}$ = 0.1800000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1210857E 03	0.9750000E 01	0.9000000E 01	0.
0.1325504E 03	0.1012600E 02	0.9911540E 01	0.1000000E-00
0.1406727E 03	0.1045878E 02	0.1061020E 02	0.4000000E 00
0.1522770E 03	0.1086906E 02	0.1171749E 02	0.5000000E 00
0.1685242E 03	0.1144710E 02	0.1312095E 02	0.6000000E 00
0.1913239E 03	0.1221211E 02	0.1498393E 02	0.7000000E 00
0.2230046E 03	0.1323079E 02	0.1746718E 02	0.8000000E 00
0.27[illegible]520E 03	0.1460734E 02	0.2003195E 02	0.9000000E 00
0.3468145E 03	0.1652467E 02	0.2552467E 02	0.1000000E 01
0.4720176E 03	0.1931817E 02	0.3237499E 02	0.1100000E 01
0.7065360E 03	0.2368960E 02	0.4311274E 02	0.1200000E 01
0.1233250E 04	0.3137615E 02	0.6202570E 02	0.1300000E 01
0.2054408E 04	0.4818690E 02	0.1036507E 03	0.1400000E 01
0.5593162E 04	0.6709512E 02	0.1500675E 03	0.1450000E 01
0.1575577E 05	0.1127718E 03	0.2627367E 03	0.1500000E 01
0.1767764E 06	0.3782909E 03	0.9178656E 03	0.1550000E 01
TENSILE END LOADS			
0.1162310E 03	0.9600529E 01	0.1153952E 01	0.3000000E 00
0.1088037E 03	0.9345308E 01	0.7516751E 01	0.4000000E 00
0.1015593E 03	0.8836533E 01	0.6702687E 01	0.5000000E 00
0.9384130E 02	0.8485907E 01	0.5965076E 01	0.6000000E 00
0.8580370E 02	0.8105249E 01	0.5023638E 01	0.7000000E 00
0.7774849E 02	0.7705723E 01	0.4268339E 01	0.8000000E 00
0.6991207E 02	0.7297271E 01	0.3084210E 01	0.9000000E 00
0.6248663E 02	0.6888125E 01	0.2111674E 01	0.1000000E 01
0.5556695E 02	0.6485679E 01	0.1152239E 01	0.1100000E 01
0.4922709E 02	0.6095[illegible] 01	0.2238573E 00	0.1200000E 01
0.4348146E 02	0.5718699E 01	0.6668014E 00	0.1300000E 01
0.3833072E 02	0.5360691E 01	-0.1509957E 01	0.1400000E 01
0.3374351E 02	0.5022551E 01	0.2279616E 01	0.1500000E 01
0.2967622E 02	0.4733529E 01	0.3042081E 01	0.1600000E 01
0.2608877E 02	0.4405379E 01	0.3739675E 01	0.1700000E 01
0.2293[illegible]E 02	0.4126725E 01	0.4375531E 01	0.1800000E 01
0.2015557E 02	0.3867695E 01	0.4941845E 01	0.1900000E 01
0.1771475E 02	0.3626621E 01	0.5503480E 01	0.2000000E 01
0.1557350E 02	0.3401199E 01	0.6007729E 01	0.2100000E 01
0.1368794E 02	0.3195694E 01	0.6468129E 01	0.2200000E 01
0.1202440E 02	0.3005392E 01	0.6880530E 01	0.2300000E 01
0.1055915E 02	0.2828024E 01	0.7277700E 01	0.2400000E 01
0.9260141E 01	0.2661248E 01	0.7632792E 01	0.2500000E 01
0.8106648E 01	0.2508559E 01	0.7957861E 01	0.2600000E 01
0.7075964E 01	0.2367019E 01	0.8255571E 01	0.2700000E 01
0.6169[illegible]E 01	0.2235262E 01	0.8528218E 01	0.2800000E 01
0.5335115E 01	0.2113405E 01	0.8777462E 01	0.2900000E 01
0.4571505E 01	0.2000747E 01	0.9003723E 01	0.3000000E 01

$\overline{T}_D$ = 0.1200000E 02 $\overline{W}$ = [illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
[illegible]E 03	0.1037500E 02	0.1050000E 02	0.
0.1495107E [illegible]	0.1077487E 02	0.1146273E 02	0.3000000E 00
0.1506466E 03	0.1110725E 02	0.1222716E 02	0.4000000E 00
0.1737789E 03	0.1156567E 02	0.1339147E 02	0.5000000E 00
0.1901350E 03	0.1217925E 02	0.1480452E 02	0.6000000E 00
0.2160269E 03	0.1299252E 02	0.1686841E 02	0.7000000E 00
0.2522067E 03	0.1407495E 02	0.1950797E 02	0.8000000E 00
0.3072055E 03	0.1553060E 02	0.2302669E 02	0.9000000E 00
0.3917021E 03	0.1757692E 02	0.2807492E 02	0.1000000E 01
0.5335701E 03	0.2054678E 02	0.3536167E 02	0.1100000E 01
0.7982555E 03	0.2519160E 02	0.4677478E 02	-0.1200000E 01
0.1391454E 04	0.3336488E 02	0.6685554E 02	0.1300000E 01
0.3269401E 04	0.5123720E 02	0.1109250E 03	0.1400000E 01
0.6320707E 04	0.7133489E 02	0.1604818E 03	0.1450000E 01
0.1780377E 05	0.1198900E 03	0.2802524E 03	0.1500000E 01
0.1997568E 06	0.4021500E 03	0.9766654E 03	0.1550000E 01
TENSILE END LOADS			
0.1254430E 03	0.1000384E 02	0.9599689E 01	0.1000000E 00
0.1228427E 03	0.9732119E 01	0.9942861E 01	0.4000000E 00
0.1148522E 03	0.9401849E 01	0.8149043E 01	0.5000000E 00
0.1059841E 03	0.9031062E 01	0.7248818E 01	0.6000000E 00
0.9688461E 02	0.8626350E 01	0.6271098E 01	0.7000000E 00
0.6778715E 02	0.8201570E 01	0.5250995E 01	0.8000000E 00
0.7894355E 02	0.7767297E 01	0.4208489E 01	0.9000000E 00
0.7055155E 02	0.7332488E 01	0.3147513E 01	0.1000000E 01
0.6276015E 02	0.6904168E 01	0.2145715E 01	0.1100000E 01
0.5558019E 02	0.6488474E 01	0.1152598E 01	0.1200000E 01
0.4909675E 02	0.6068812E 01	0.2098742E-00	0.1[illegible]E 01
[illegible]1201821E 02	0.5708162E 01	0.6479573E 00	0.14[illegible]E 01
0.3110330E 02	0.5348354E 01	0.1533107E 01	0.1500000E 01
0.3351802E 02	0.5009285E 01	0.2321770E 01	0.1600000E 01
0.2947301E 02	0.4692017E 01	0.3059910E 01	0.1700000E 01
0.2591399E 02	0.4395674E 01	0.3742612E 01	0.1800000E 01
0.2278723E 02	0.4120161E 01	0.4173782E 01	0.1900000E 01
0.2004177E 02	0.3861095E 01	0.4955315E 01	0.2000000E 01
0.1763048E 02	0.3626209E 01	0.5491[illegible]E 01	0.2100000E 01
0.1551003E 02	0.3405783E 01	0.5981987E 01	0.2200000E 01
0.1364477E 02	0.3201524E 01	0.6434064E 01	0.2300000E 01
0.1199660E 02	0.3012290E 01	0.6850793E 01	0.2400000E 01
0.1054811E 02	0.2836970E 01	0.7231044E 01	0.2500000E 01
0.9252491E 01	0.2675502E 01	-0.7579634E 01	0.2600000E 01
0.8104265E 01	0.2523884E 01	0.7889113E 01	0.2700000E 01
0.7079425E 01	0.2386175E 01	0.8191932E 01	0.2800000E 01
0.4161231E 01	0.2254502E 01	0.8460361E 01	0.2900000E 01
0.5335118E 01	0.2134055E 01	0.8706497E 01	0.3000000E 01

TABLE 1.5-1 (Cont'd)

VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = -0.1200000E 02 $\overline{W}$ = 0.2400000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1558857E 03	0.1100000E 02	0.1200000E 02	0.
0.1678674E 03	0.1142348E 02	0.1302811E 02	-0.3000000E-00
0.1781756E 03	0.1177574E 02	0.1386412E 02	-0.4000000E-00
0.1928837E 03	0.1226138E 02	0.1506534E 02	-0.5000000E 00
0.2134776E 03	0.1291137E 02	0.1664809E 02	-0.6000000E 00
0.2423784E 03	0.1377296E 02	0.1874974E 02	-0.7000000E 00
0.2836796E 03	0.1491761E 02	0.2154855E 02	-0.8000000E 00
0.3446918E 03	0.1647041E 02	0.2534103E 02	-0.9000000E 00
0.4395021E 03	0.1862957E 02	0.3062937E 02	-0.1000000E 01
0.5982366E 03	0.2177540E 02	0.3834823E 02	-0.1100000E 01
0.8955770E 03	0.2669780E 02	0.5044483E 02	-0.1200000E 01
0.1563402E 04	0.3535360E 02	0.[illegible]4759E 02	-0.1300000E 01
0.3668361E 04	0.5428557E 02	0.11[illegible]E 03	-0.1400000E 01
0.7091748E 04	0.7557467E 02	0.1708957E 03	-0.1450000E 01
0.1997694E 05	0.1270081E 03	0.2977682E 03	-0.1500000E 01
0.2241410E 06	0.4260001E 03	0.1035465E 04	-0.1550000E 01
TENSILE END LOADS			
0.1451682E 03	0.1060639E 02	0.1104542E 02	0.3000000E-00
0.1375351E 03	0.1031193E 02	0.1034897E 02	0.4000000E-00
0.1286060E 03	0.9971146E 01	0.9507214E 01	0.5000000E 00
0.1188268E 03	0.9576216E 01	0.8552562E 01	0.6000000E 00
0.1086424E 03	0.9147451E 01	0.7517749E 01	0.7000000E 00
0.9843834E 02	0.8697419E 01	0.6433652E 01	0.8000000E 00
0.8851964E 02	0.8237121E 01	0.5327769E 01	0.9000000E 00
0.7910820E 02	0.7776651E 01	0.4223349E 01	0.1000000E 01
0.7034875E 02	0.7323056E 01	0.3139102E 01	0.1100000E 01
0.6232072E 02	0.6802409E 01	0.2089131E 01	0.1200000E 01
0.5505225E 02	0.6458965E 01	0.1084350E 01	0.1300000E 01
0.4853402E 02	0.6055592E 01	0.1310398E-00	0.1400000E 01
0.4273133E 02	0.5674017E 01	-0.7665306E 00	0.1500000E 01
0.3759391E 02	0.5315061E 01	-0.1606557E 01	0.1600000E 01
0.3306339E 02	0.4978856E 01	-0.2388893E 01	0.1700000E 01
0.2907862E 02	0.4665023E 01	-0.3114674E 01	0.1800000E 01
0.2557929E 02	[illegible]372828E 01	-0.3785908E 01	0.1900000E 01
0.2250822E 02	[illegible]101297E 01	-0.4405187E 01	0.2000000E 01
0.1981258E 02	0.3849110E 01	-0.4975456E 01	0.2100000E 01
0.1744457E 02	0.3615671E 01	-0.5499846E 01	0.2200000E 01
0.1536150E 02	0.3399157E 01	-0.5981539E 01	0.2300000E 01
0.1352566E 02	0.3198557E 01	0.6423686E 01	0.2400000E 01
0.1190399E 02	0.3012694E 01	0.6829319E 01	0.2500000E 01
0.1046769E 02	0.2840445E 01	0.7201411E 01	0.2600000E 01
0.9191761E 01	0.2680748E 01	-0.7542654E 01	0.2700000E 01
0.8055561E 01	0.2532608E 01	-0.7855645E 01	0.2800000E 01
0.7037406E 01	0.2395099E 01	-0.8142780E 01	0.2900000E 01
0.6124175E 01	0.2267364E 01	-0.8406273E 01	0.3000000E 01

$\overline{T}_D$ = -0.1600000E 02 $\overline{W}$ = 0.

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.8533333E 02	0.8000000E 01	0.	0.
0.9184519E 02	0.8311396E 01	0.7480257E 00	-0.3000000E-00
0.9744352E 02	0.8570443E 01	0.1371271E 01	-0.4000000E-00
0.1054325E 03	0.8927611E 01	0.2231903E 01	-0.5000000E 00
0.1166165E 03	0.9405702E 01	0.3386053E 01	-0.6000000E 00
0.1323084E 03	0.1003949E 02	0.4919348E 01	-0.7000000E 00
0.1547281E 03	0.1088310E 02	0.6965187E 01	-0.8000000E 00
0.1878403E 03	0.1202471E 02	0.9739613E 01	-0.9000000E 00
0.2392849E 03	0.1361305E 02	0.1361305E 02	-0.1000000E 01
0.3253995E 03	0.1592965E 02	0.1927367E 02	-0.1100000E 01
0.4466848E 03	0.1955226E 02	0.2815526E 02	-0.1200000E 01
0.8488909E 03	0.2592506E 02	0.4381335E 02	-0.1300000E 01
0.1990472E 04	0.3986522E 02	0.7813584E 02	-0.1400000E 01
0.3847030E 04	0.5554198E 02	0.1167770E 03	-0.1450000E 01
0.1083481E 05	0.9341748E 02	0.2101893E 03	-0.1500000E 01
0.1215549E 06	0.3135292E 03	0.7534220E 03	-0.1550000E 01
TENSILE END LOADS			
0.7749444E 02	0.7710523E 01	-0.6939534E 00	0.3000000E-00
0.7536021E 02	0.7499255E 01	0.1129981E 01	0.4000000E 00
0.7050505E 02	0.7243591E 01	-0.1810490E 01	0.5000000E 00
0.6518616E 02	0.6953302E 01	-0.2503189E 01	0.6000000E 00
0.5964547E 02	0.6638109E 01	0.3252[illegible]12E 01	0.7000000E 00
0.5409169E 02	0.6307502E 01	-0.4036401E 01	0.8000000E 00
0.4868976E 02	0.5969449E 01	0.4835286E 01	0.9000000E 00
0.4356067E 02	0.5631133E 01	0.5631132E 01	0.1000000E 01
0.3878240E 02	0.5298062E 01	-0.6410655E 01	0.1100000E 01
0.3439930E 02	0.4974593E 01	-0.7183421E 01	0.1200000E 01
0.3047552E 02	0.4663972E 01	0.7811940E 01	0.1300000E 01
0.2685645E 02	0.4367284E 01	-0.8561248E 01	0.1400000E 01
0.2367339E 02	0.4088236E 01	-0.9194463E 01	0.1500000E 01
0.2084912E 02	0.3825136E 01	-0.9772349E 01	0.1600000E 01
0.1835208E 02	0.3578866E 01	-0.1035292E 02	0.1700000E 01
0.1616910E 02	0.3349112E 01	-0.1085112E 02	0.1800000E 01
0.1426779E 02	0.3135327E 01	0.1131145E 02	0.1900000E 01
0.1249695E 02	0.2936791E 01	-0.1174716E 02	0.2000000E 01
0.1099809E 02	0.2752473E 01	0.1211392E [illegible]	0.2100000E 01
0.9655[illegible]E 01	0.2580298E 01	0.1242230E 02	0.2200000E 01
0.8475549E 01	0.2426130E 01	0.1282364E 02	0.2300000E 01
0.7428461E 01	0.2277933E 01	-0.1312072E 02	0.2400000E 01
0.6496069E 01	0.2142539E 01	0.1337086E 02	0.2500000E 01
0.5662831E 01	0.2017222E 01	0.1363620E 02	0.2600000E 01
0.4915227E 01	0.1901113E 01	-0.1385909E 02	0.2700000E 01
0.4241555E 01	0.1793526E 01	-0.1406125E 02	0.2800000E 01
0.3631772E 01	0.1693746E 01	-0.1424457E 02	0.2900000E 01
0.3076979E 01	0.1601195E [illegible]	0.1441375E 02	0.3000000E 01

$\overline{T}_D$ = 0.1600000E 02 $\overline{W}$ = 0.1600000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.9861905E 02	0.8425000E 01	0.1500000E 01	0.
0.1061566E 03	0.8960138E 01	0.2160612E 01	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = [illegible] $\overline{W}$ = [illegible] 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	0.
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = -0.1600000E 02 $\overline{W}$ = 0.9000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1281048E 03	0.9875000E 01	0.4500000E 01	0.
0.1379121E 03	0.1025762E 02	0.5423186E 01	-0.3000000E-00
0.1463451E 03	0.1057591E 02	0.6192145E 01	-0.4000000E-00
0.1583801E 03	0.1101474E 02	0.7253684E 01	-0.5000000E 00
0.1752301E 03	0.1160211E 02	0.8676760E 01	-0.6000000E 00
0.1988749E 03	0.1238073E 02	0.1056656E 02	-0.7000000E 00
0.2326620E 03	0.1341708E 02	0.1308693E 02	-0.8000000E 00
0.2825696E 03	0.1481881E 02	0.1650323E 02	-0.9000000E 00
0.3601179E 03	0.1677039E 02	0.2127039E 02	-0.1000000E 01
0.4879427E 03	0.1961449E 02	0.2823354E 02	-0.1100000E 01
0.7331157E 03	0.2406486E 02	0.3915340E 02	-0.1200000E 01
0.1279257E 04	0.3109124E 02	0.5839619E 02	-0.1300000E 01
0.3000629E 04	0.4901022E 02	0.1005600E 03	-0.1400000E 01
0.5800143E 04	0.6826130E 02	0.1480194E 03	-0.1450000E 01
0.1633712E 05	0.1147718E 03	0.2627367E 03	-0.1500000E 01
0.1032938E 06	0.3851494E 03	0.9298216E 03	-0.1550000E 01
TENSILE END LOADS			
0.1193151E 03	0.9519385E 01	0.3643255E 01	0.3000000E-00
0.1130867E 03	0.9259688E 01	0.3018450E 01	0.4000000E-00
0.1057772E 03	0.8945511E 01	0.2263622E 01	0.5000000E 00
0.9777091E 02	0.8588767E 01	0.1408344E 01	0.6000000E 00
0.8943255E 02	0.8201492E 01	0.4812687E-00	0.7000000E 00
0.8107662E 02	0.7795049E 01	-0.4888314E-00	0.8000000E 00
0.7295265E 02	0.7379566E 01	-0.1477448E 01	0.9000000E 00
0.6524215E 02	0.6963620E 01	-0.2463620E 01	0.1000000E 01
0.5806356E 02	0.6554128E 01	-0.3430495E 01	0.11[illegible]0E 01
0.5148188E 02	0.6156396E 01	-0.4365210E 01	0.1200000E 01
0.4552019E 02	0.5774268E 01	-0.5258513E 01	0.1300000E 01
0.4017093E 02	0.5410335E 01	-0.6104257E 01	0.1400000E 01
0.3540578E 02	0.5066154E 01	-0.6898848E 01	0.1500000E 01
0.3118369E 02	0.4742465E 01	-0.7640710E 01	0.1600000E 01
0.2745700E 02	0.4439381E 01	-0.8329810E 01	0.1700000E 01
0.2417575E 02	0.4156550E 01	-0.8967246E 01	0.1800000E 01
0.2129069E 02	0.3893327E 01	-0.9554921E 01	0.1900000E 01
0.1875510E 02	0.3648905E 01	-0.1009522E 02	0.2000000E 01
0.1652583E 02	0.3421975E 01	-0.1059091E 02	0.2100000E 01
0.1456385E 02	0.3211752E 01	-0.1104468E 02	0.2200000E 01
0.1283428E 02	0.3017027E 01	-0.1146007E 02	0.2300000E 01
0.1130633E 02	0.2836701E 01	-0.1183940E 02	0.2400000E 01
0.9953004E 01	0.2669709E 01	-0.1218568E 02	0.2500000E 01
0.8750778E 01	0.2515031E 01	-0.1250161E 02	0.2600000E 01
0.7679238E 01	0.2371704E 01	-0.1278977E 02	0.2700000E 01
0.6720715E 01	0.2238825E 01	-0.1305239E 02	0.2800000E 01
0.5859952E 01	0.2115556E 01	-0.1329183E 02	0.2900000E 01
0.5083786E 01	0.2001120E 01	-0.1351008E 02	0.3000000E 01

$\overline{T}_D$ = -0.1600000E 02 $\overline{W}$ = 0.1200000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1443048E 03	0.1050000E 02	0.6000000E 01	0.
0.1555602E 03	0.1090636E 02	0.6981573E 01	-0.3000000E-00
0.1648673E 03	0.1124439E 02	0.7799103E 01	-0.4000000E-00
0.1784349E 03	0.1171044E 02	0.8927611E 01	-0.5000000E 00
0.1974312E 03	0.1233425E 02	0.1044033E 02	-0.6000000E 00
0.2240886E 03	0.1316115E 02	0.1244896E 02	-0.7000000E 00
0.2621817E 03	0.1425174E 02	0.1512752E 02	-0.8000000E 00
0.3184516E 03	0.1575034E 02	0.1875777E 02	-0.9000000E 00
0.4058882E 03	0.1782294E 02	0.2382264E 02	-0.1000000E 01
0.5522709E 03	0.2084311E 02	0.3122016E 02	-0.1100000E 01
0.8264637E 03	0.2556906E 02	0.4281345E 02	-0.1200000E 01
0.1442282E 04	0.3387996E 02	0.6325714E 02	-0.1300000E 01
0.3383284E 04	0.5205855E 02	0.1080348E 03	-0.1400000E 01
0.6539999E 04	0.7250107E 02	0.1584335E 03	0.1450000E 01
0.1842144E 05	0.1218900E 03	0.2802524E 03	-0.1500000E 01
0.2066812E 06	0.4089995E 03	0.9886214E 03	-0.1550000E 01
TENSILE END LOADS			
0.1343989E 03	0.1012231E 02	0.5088992E 01	0.3000000E 00
0.1273756E 03	0.9846499E 01	0.4424560E 01	0.4000000E-00
0.1191364E 03	0.9512017E 01	0.3621776E 01	0.5000000E 00
0.1101122E 03	0.9133222E 01	0.2711788E 01	0.6000000E 00
0.1007140E 03	0.8722594E 01	0.1725929E 01	0.7000000E 00
0.9129673E 02	0.8290895E 01	0.6938253E 00	0.8000000E 00
0.8214150E 02	0.7849592E 01	-0.3581693E-00	0.9000000E 00
0.7345325E 02	0.7407783E 01	-0.1407783E 01	0.1000000E 01
0.6536528E 02	0.6972817E 01	-0.2437108E 01	0.1100000E 01
0.5795094E 02	0.6550328E 01	-0.3432473E 01	0.1200000E 01
0.5123625E 02	0.6144401E 01	-0.4384038E 01	0.1300000E 01
0.4521267E 02	0.5757786E 01	-0.5285260E 01	0.1400000E 01
0.3984825E 02	0.5392137E 01	-0.6132309E 01	0.1500000E 01
0.3509671E 02	0.5048243E 01	-0.6923497E 01	0.1600000E 01
0.3090425E 02	0.4726219E 01	-0.7658773E 01	0.1700000E 01
0.2721456E 02	0.4425706E 01	-0.8339288E 01	0.1800000E 01
0.2397228E 02	0.4145993E 01	-0.8967036E 01	0.1900000E 01
0.2112411E 02	0.3886143E 01	-0.9544571E 01	0.2000000E 01
0.1862200E 02	0.3645076E 01	-0.1007478E 02	0.2100000E 01
0.1642170E 02	0.3421640E 01	-0.1056074E 02	0.2200000E 01
0.1448390E 02	0.3214459E 01	-0.1100555E 02	0.2300000E 01
0.1277386E 02	0.3022968E 01	-0.1141229E 02	0.2400000E 01
0.1126112E 02	0.2845453E 01	-0.1178396E 02	0.2500000E 01
0.9919170E 01	0.2680974E 01	-0.1212338E 02	0.2600000E 01
0.8724965E 01	0.2528568E 01	-0.1243326E 02	0.2700000E 01
0.7658563E 01	0.2387758E 01	-0.1271610E 02	0.2800000E 01
0.6702813E 01	0.2256153E 01	-0.1297425E 02	0.2900000E 01
0.5842809E 01	0.2134428E 01	-0.1320986E 02	0.3000000E 01

$\overline{T}_D$ = -0.1600000E 02 $\overline{W}$ = 0.1500000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1634762E 03	0.1112500E 02	0.7500000E 01	0.
0.1738545E 03	0.1155510E 02	0.8539959E 01	-0.300[illegible]001-00
0.1845004E 03	0.1191288E 02	0.9406081E 01	-0.4000000E 00
0.1996925E 03	0.1240615E 02	0.1060154E 02	-0.[illegible]000000E 00
0.2209639E 03	0.1306538E 02	0.1220390E 02	0.6000000E 00
0.2500146E 03	0.1394136E 02	0.1433115[illegible] 02	0.7000000E 00
0.2934772E 03	0.1510640E 02	0.1716810E 02	0.8000000E 00
0.3564084E 03	0.1668187E 02	0.2101231E 02	0.9000000E 00
0.4544049E 03	0.1887529E 02	0.2637529E 02	-0.1000000E 01
0.6183392E 03	0.2207172E 02	0.3420670E 02	0.1100000E 01
0.9254113E 03	0.2707126E 02	0.4640550E 02	0.1200000E 01
0.1613091E 04	0.3586869E 02	0.6611509E 02	-0.1300000E 01
0.3788906E 04	0.5510680E 02	0.1155095E 03	0.1400000E 01
0.7324264E 04	0.7674085E 02	0.1688576E 03	-0.1450000E 01
0.2061008E 05	0.1290081E 03	0.2977682E 03	0.1500000E 01
0.2314723E 06	0.4320496E 03	0.1047421E 04	0.1550000E 01
TENSILE END LOADS			
0.1503580E 03	0.1072524E 02	0.5544728E 01	0.1000000E 00
0.1425211E 03	0.1043351E 02	0.5830629E 01	0.4000000E 00
0.1332965E 03	0.1009012E 02	0.4979967E 01	0.5000000E 00
0.1231933E 03	0.9679077E 01	0.4015532E 01	0.6000000E 00
0.1126718E 03	0.9243695E 01	0.2970559E 01	0.7000000E 00
0.1021294E 03	0.8786747E 01	0.1876482E 01	0.8000000E 00
0.9188115E 02	0.8319618E 01	0.7511076E 00	0.9000000E 00
0.8215632E 02	0.7851946E 01	0.3519457E 00	0.1000000E 01
0.7310459E 02	0.7391508E 01	0.1441772E 01	0.1100000E 01
0.6480743E 02	0.6944261E 01	0.2499736E 01	0.1200000E 01
0.5729457E 02	0.6514534E 01	0.3509562E 01	0.1300000E 01
0.5055872E 02	0.6105236E 01	0.4465261E 01	0.1400000E 01
0.4455457E 02	0.5718120E 01	0.5365770E 01	0.1500000E 01
0.3924590E 02	0.5354017E 01	-0.6206283E 01	0.1600000E 01
0.3455764E 02	0.5013057E 01	-0.6987735E 01	0.1700000E 01
0.3043502E 02	0.4694855E 01	0.7711330E 01	0.1800000E 01
0.2681168E 02	0.4398660E 01	0.8379161E 01	0.1900000E 01
0.2363460E 02	0.4123481E 01	-0.8993921E 01	0.2000000E 01
0.2084329E 02	0.3868176E 01	-0.9558657E 01	0.2100000E 01
0.1839040E 02	0.3631528E 01	0.1007660E 02	0.2200000E 01
0.1623180E 02	0.3412294E 01	0.1055102E 02	0.2300000E 01
0.1432084E 02	0.3209234E 01	0.1098519E 02	0.2400000E 01
0.1264715E 02	0.3021157E 01	0.1135223E 02	0.2500000E 01
0.1115710E 02	0.2846917E 01	0.1174510E 02	0.2600000E 01
0.9837087E 01	0.2685442E 01	0.1207640E 02	0.2700000E 01
0.8[illegible]91E 01	0.2535491E 01	0.1237982E 02	0.2800000E 01
0.759[illegible]33E 01	0.2394750E 01	-0.1265667E 02	0.2900000E 01
0.6646377E 01	0.2261757E 01	0.1290943E 02	0.3000000E 01

$\overline{T}_D$ = 0.1600000E 02 $\overline{W}$ = 0.1800000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1796190E 03	0.1175000E 02	0.9000000E 01	0.
0.1913952E 03	0.1220385E 02	0.1009043E 02	0.3000000E 00
0.2052440E 03	0.1258157E 02	0.1101302E 02	0.4000000E 00
0.2221529E 03	0.1310184E 02	0.1227547E 02	0.5000000E 00
0.2558283E 03	0.1379852E 02	0.1396747E 02	0.6000000E 00
0.2790534E 03	0.1472198E 02	0.1621377E 02	0.7000000E 00
0.3265339E 03	0.1595104E 02	0.1920868E 02	0.8000000E 00
0.3966759E 03	0.1761340E 02	0.2326685E 02	0.9000000E 00
0.5056670E 03	0.1992773E 02	0.2092773E 02	0.1000000E 01
0.6881478E 03	0.2330033E 02	0.3719469E 02	0.1100000E 01
0.1029966E 04	0.2857747E 02	0.5015155E 02	0.1200000E 01
0.1797685E 04	0.3785742E 02	0.7291903E 02	0.1300000E 01
0.4217497E 04	0.5815521E 02	0.1229842E 03	0.1400000E 01
0.8152919E 04	0.8098042E 02	0.1792017E 03	-0.1450000E 01
0.2296543E 05	0.1361262E 03	0.3152640E 03	0.1500000E 01
0.2576675E 06	0.4566897E 03	0.1136221E 04	0.1550000E 01
TENSILE END LOADS			
0.1672819E 03	0.1113261E 02	0.7980464E 01	0.3000000E 00
0.1585213E 03	0.1102312E 02	0.7216791E 01	0.4000000E 00
0.1482575E 03	0.1066745E 02	0.6338147E 01	0.5000000E 00
0.1370142E 03	0.1022423E 02	0.5311927E 01	0.6000000E 00
0.1253057E 03	0.9764796E 01	0.4215250E 01	0.7000000E 00
0.1135745E 03	0.9202598E 01	0.[illegible]591138E 01	0.8000000E 00
0.1021714E 03	0.8709864E 01	0.1830369E 01	0.9000000E 00
0.9135115E 02	0.8295135E 01	0.7038915E 00	0.1000000E 01
0.8128009E 02	0.7810194E 01	0.4503353E 00	[illegible]1100000E 01
[illegible]7205113E 02	0.7338193E 01	0.1566928E 01	0.1200000E 01
0.6169535E 02	0.6894627E 01	0.2615086E 01	0.1300000E 01
0.5520135E 02	0.6452687E 01	0.3647264E 01	0.1400000E 01
0.4751079E 02	0.6044125E 01	0.4599232E 01	0.1500000E 01
0.4302497E 02	0.5659273E 01	0.5487270E 01	0.1600000E 01
0.3841718E 02	0.5299896E 01	0.6116678E 01	0.1700000E 01
0.3383712E 02	0.4964003E 01	0.7083371E 01	0.1800000E 01
0.2981549E 02	0.4451372E 01	0.7791289E 01	0.1900000E 01
0.2628657E 02	0.4360841E 01	0.8443274E 01	0.2000000E 01
0.2318975E 02	0.4091277E 01	0.9042553E 01	0.2100000E 01
0.2046993E 02	0.3841436E 01	0.9592456E 01	0.2200000E 01
0.1807333E 02	0.3699924E 01	0.1009645E 02	0.2300000E 01
0.1597121E 02	0.3395500E 01	0.1055800E 02	0.2400000E 01
0.1411108E 02	0.3196581E 01	0.1098059E 02	0.2500000E 01
0.1246457E 02	0.3012860E 01	0.1136479E 02	0.2600000E 01
0.1100300E 02	0.2842297E 01	0.1172314E 02	0.2700000E 01
0.9701540E 01	0.2684124E 01	0.1204543E 02	0.2800000E 01
0.8538707E 01	0.2537347E 01	0.1233900E 02	0.2900000E 01
0.7445908E 01	0.2401765E 01	0.1260943E 02	0.3000000E 01

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = -0.1600000E 02 $\overline{W}$ = 0.2100000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1987333E 03	0.1237500E 02	0.1050000E 02	0.
0.2139823E 03	0.1285259E 02	0.1165673E 02	-0.3000000E-00
0.2270987E 03	0.1324986E 02	0.1261998E 02	-0.4000000E-00
0.2458161E 03	0.1379757E 02	0.1394939E 02	-0.5000000E 00
0.2720242E 03	0.1453066E 02	0.1573104E 02	-0.6000000E 00
0.3088045E 03	0.1550239E 02	0.1809617E 02	-0.7000000E 00
0.3613664E 03	0.1679572E 02	0.2124926E 02	-0.8000000E 00
0.4390142E 03	0.1854493E 02	0.2552139E 02	-0.9000000E 00
0.5596771E 03	0.2098018E 02	0.3148018E 02	-0.1000000E 01
0.7616966E 03	0.2452895E 02	0.4018003E 02	-0.1100000E 01
0.1140123E 04	0.3008167E 02	0.5381760E 02	-0.1200000E 01
0.1990063E 04	0.3984614E 02	0.7785982E 02	-0.1300000E 01
0.4669056E 04	0.6120354E 02	0.1304509E 03	-0.1400000E 01
0.9026074E 04	0.8522039E 02	0.1896759E 03	-0.1450000E 01
0.2542509E 05	0.1432463E 03	0.3327998E 03	-0.1500000E 01
0.2852662E 06	0.4805498E 03	0.1165023E 04	-0.1550000E 01
TENSILE END LOADS			
0.1850813E 03	0.1193111E 02	0.9626204E 01	0.3000000E-00
0.1753823E 03	0.1160693E 02	0.8642891E 01	0.4000000E-00
0.1640194E 03	0.1121474E 02	0.7676314E 01	0.5000000E 00
0.1515750E 03	0.1076939E 02	0.6673021E 01	0.6000000E 00
0.1386159E 03	0.1028592E 02	0.5659910E 01	0.7000000E 00
0.1256323E 03	0.9778445E 01	0.4241795E 01	0.8000000E 00
0.1130123E 03	0.9257669E 01	0.2999668E 01	0.9000000E 00
0.1010364E 03	0.8747171E 01	0.1759729E 01	0.1000000E 01
0.8989400E 02	0.8226083E 01	0.5430515E 00	0.1100000E 01
0.7968271E 02	0.7732126E 01	-0.6342611E 00	0.1200000E 01
0.7043795E 02	0.7254799E 01	-0.1760611E 01	0.1300000E 01
0.6214866E 02	0.6800137E 01	-0.2828269E 01	0.1400000E 01
0.5477073E 02	0.6370886E 01	-0.3832693E 01	0.1500000E 01
0.4824022E 02	0.5965569E 01	-0.4771857E 01	0.1600000E 01
0.4248286E 02	0.5586734E 01	-0.5645661E 01	0.1700000E 01
0.3742086E 02	0.5233152E 01	-0.6455413E 01	0.1800000E 01
0.3297751E 02	0.4903993E 01	-0.7203415E 01	0.1900000E 01
0.2908002E 02	0.4598157E 01	-0.7892626E 01	0.2000000E 01
0.2566123E 02	0.4314377E 01	-0.8526404E 01	0.2100000E 01
0.2266011E 02	0.4051304E 01	-0.9108113E 01	0.2200000E 01
0.2002294E 02	0.3807557E 01	-0.9641975E 01	0.2300000E 01
0.1770116E 02	0.3581766E 01	-0.1013097E 02	0.2400000E 01
0.1565292E 02	0.3372605E 01	-0.1057878E 02	0.2500000E 01
0.1384357E 02	0.3178803E 01	-0.1098971E 02	0.2600000E 01
0.1223532E 02	0.2999161E 01	-0.1136389E 02	0.2700000E 01
0.1080653E 02	0.2832557E 01	-0.1170724E 02	0.2800000E 01
0.9531740E 01	0.2677943E 01	-0.1202150E 02	0.2900000E 01
0.8390143E 01	0.2534556E 01	-0.1230918E 02	0.3000000E 01

$\overline{T}_D$ = -0.1600000E 02 $\overline{W}$ = 0.2400000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.2188190E 03	0.1300000E 02	0.1200000E 02	0.
0.2356155E 03	0.1350133E 02	0.1321512E 02	-0.3000000E-00
0.2500641E 03	0.1391835E 02	0.1422694E 02	-0.4000000E-00
0.2706822E 03	0.1449329E 02	0.1562332E 02	-0.5000000E 00
0.2995519E 03	0.1526280E 02	0.1749461E 02	-0.6000000E 00
0.3400679E 03	0.1628281E 02	0.1997858E 02	-0.7000000E 00
0.3979697E 03	0.1764038E 02	0.2328984E 02	-0.8000000E 00
0.4835074E 03	0.1947646E 02	0.2777593E 02	-0.9000000E 00
0.6164327E 03	0.2203263E 02	0.3403263E 02	-0.1000000E 01
0.8389855E 03	0.2575756E 02	0.4316635E 02	-0.1100000E 01
0.1255877E 04	0.3158587E 02	0.5748365E 02	-0.1200000E 01
0.2192225E 04	0.4183487E 02	0.8270093E 02	-0.1300000E 01
0.5143583E 04	0.6425187E 02	0.1379337E 03	-0.1400000E 01
0.9943517E 04	0.8946016E 02	0.2000900E 03	-0.1450000E 01
0.2800987E 05	0.1503625E 03	0.3503155E 03	-0.1500000E 01
0.3142689E 06	0.5043999E 03	0.1223821E 04	-0.1550000E 01
TENSILE END LOADS			
0.2037852E 03	0.1253404E 02	0.1087194E 02	0.3000000E-00
0.1930978E 03	0.1219374E 02	0.1004900E 02	0.4000000E-00
0.1805822E 03	0.1178204E 02	0.9054489E 01	0.5000000E 00
0.1668756E 03	0.1131454E 02	0.7926765E 01	0.6000000E 00
0.1526025E 03	0.1080700E 02	0.6704571E 01	0.7000000E 00
0.1383025E 03	0.1027429E 02	0.5424452E 01	0.8000000E 00
0.1244018E 03	0.9729695E 01	0.4118947E 01	0.9000000E 00
0.1112173E 03	0.9184434E 01	0.2815566E 01	0.1000000E 01
0.9894610E 02	0.8647572E 01	0.1536438E 01	0.1100000E 01
0.8770350E 02	0.8126050E 01	0.2984761E-00	0.1200000E 01
0.7752331E 02	0.7624932E 01	-0.8861352E 00	0.1300000E 01
0.6839757E 02	0.7147598E 01	-0.2009272E 01	0.1400000E 01
0.6027657E 02	0.6696049E 01	-0.3066154E 01	0.1500000E 01
0.5300955E 02	0.6271345E 01	-0.4054644E 01	0.1600000E 01
0.4675467E 02	0.5873572E 01	-0.4974623E 01	0.1700000E 01
0.4118625E 02	0.5502311E 01	-0.5827454E 01	0.1800000E 01
0.3629973E 02	0.5156659E 01	-0.6615541E 01	0.1900000E 01
0.3201496E 02	0.4835494E 01	-0.7341970E 01	0.2000000E 01
0.2825789E 02	0.4537479E 01	-0.8010278E 01	0.2100000E 01
0.2496152E 02	0.4261193E 01	-0.8624171E 01	0.2200000E 01
0.2206601E 02	0.4005189E 01	-0.9187451E 01	0.2300000E 01
0.1951850E 02	0.3768032E 01	-0.9703866E 01	0.2400000E 01
0.1727266E 02	0.3548329E 01	-0.1017765E 02	0.2500000E 01
0.1528812E 02	0.3344766E 01	-0.1061048E 02	0.2600000E 01
0.1352987E 02	0.3156026E 01	-0.1100743E 02	0.2700000E 01
0.1196766E 02	0.2980989E 01	-0.1137066E 02	0.2800000E 01
0.1057683E 02	0.2818540E 01	-0.1170392E 02	0.2900000E 01
0.9329342E 01	0.2667362E 01	-0.1200896E 02	0.3000000E 01

$\overline{T}_D$ = -0.2000000E 02 $\overline{W}$ = 0.

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1333333E 03	0.1000000E 02	0.	0.
0.1416997E 03	0.1018924E 02	0.7153121E 00	-0.3000000E-00
0.1522435E 03	0.1071305E 02	0.1716009E 01	-0.4000000E 00
0.1651148E 03	0.1115953E 02	0.2703972E 01	-0.5000000E 00
0.1821295E 03	0.1175713E 02	0.4232560E 01	-0.6000000E 00
0.2066860E 03	0.1254736E 02	0.6164185E 01	-0.7000000E 00
0.2417027E 03	0.1360388E 02	0.8706434E 01	-0.8000000E 00
0.2914246E 03	0.1503027E 02	0.1217457E 02	-0.9000000E 00
0.3737889E 03	0.1701631E 02	0.1701631E 02	-0.1000000E 01
0.5083232E 03	0.1991042E 02	0.2402209E 02	-0.1100000E 01
0.7601100E 03	0.2446331E 02	0.3552407E 02	-0.1200000E 01
0.1326235E 04	0.3240612E 02	0.5476686E 02	-0.1300000E 01
0.3109929E 04	0.4981153E 02	0.9756979E 02	-0.1400000E 01
0.6010767E 04	0.6942768E 02	0.1457113E 03	-0.1450000E 01
0.1692910E 05	0.1167710E 03	0.2427367E 03	-0.1500000E 01
0.1899294E 06	0.3919990E 03	0.8477775E 03	-0.1550000E 01
TENSILE END LOADS			
0.1142165E 03	0.9638282E 01	0.8624417E 01	0.3000000E-00
0.1172554E 03	0.9374068E 01	0.1499551E 01	0.4000000E 00
0.1101076E 03	0.9054404E 01	0.2765522E 01	0.5000000E 00
0.1016371E 03	0.8691627E 01	0.3112746E 01	0.6000000E 00
0.9324190E 02	0.8297734E 01	0.4055991E 01	0.7000000E 00
0.8457795E 02	0.7864377E 01	-0.5346201E 01	0.8000000E 00
0.7615369E 02	0.7461861E 01	0.6344107E 01	0.9000000E 00
0.6815729E 02	0.7030913E 01	0.7038215E 01	0.1000000E 01
0.6071157E 02	0.6622578E 01	0.6311516E 01	0.1100000E 01
0.5395491E 02	0.6218464E 01	0.4954271E 01	0.1200000E 01
0.4769430E 02	0.5829831E 01	0.4052425E 01	0.1300000E 01
0.4214024E 02	0.5459279E 01	0.1070158E 02	0.1400000E 01
0.3720260E 02	0.5110257E 01	-0.1149860E 02	0.1500000E 01
0.3281875E 02	0.4781420E 01	0.1224034E 02	0.1600000E 01
0.2894847E 02	0.4471582E 01	0.1292465E 02	0.1700000E 01
0.2553585E 02	0.4184340E 01	0.135[illegible]	0.1800000E 01
0.2253811E 02	0.3939154E 01	0.1474816E 02	0.1900000E 01
0.1990148E 02	0.3676091E 01	-0.1468396E 02	0.2000000E 01
0.1758732E 02	0.3462841E 01	0.1517413E 02	0.2100000E 01
0.1554070E 02	0.3227629E 01	-0.1562163E 02	0.2200000E 01
0.1373904E 02	0.3030162E 01	0.1602953E 02	0.2300000E 01
0.1214697E 02	0.2847370E 01	0.1640090E 02	0.2400000E 01
0.1073160E 02	0.2678772E 01	0.1671057E 02	0.2500000E 01
0.9481925E 01	0.2521402E 01	-0.1704536E 02	0.2600000E 01
0.8363479E 01	0.2375580E 01	0.1732587E 02	0.2700000E 01
0.7362450E 01	0.2241908E 01	-0.1757656E 02	0.2800000E 01
0.6462987E 01	0.2111707E 01	0.1780371E 02	0.2900000E 01
0.5651330E 01	0.2001493E 01	-0.1801344E 02	0.3000000E 01

$\overline{T}_D$ = -0.2000000E 02 $\overline{W}$ = 0.1000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1498190E 03	0.1062500E 02	0.1500000E 01	0.
0.1612556E 03	0.1103799E 02	0.2493419E 01	-0.3000000E 00
0.1770888E 03	0.1138154E 02	0.3521047E 01	-0.4000000E 00
0.1851225E 03	0.1185522E 02	0.4463004E 01	-0.5000000E 00
0.2041709E 03	0.1248926E 02	0.5796135E 01	0.6000000E 00
0.2323424E 03	0.1337977E 02	0.8031589E 01	0.7000000E 00
0.2717402E 03	0.1444854E 02	0.1074707E 02	0.8000000E 00
0.3299350E 03	0.1596180E 02	0.1442906E 02	0.9000000E 00
0.4203598E 03	0.1806876E 02	0.1956876E 02	0.1000000E 01
0.5717401E 03	0.2113943E 02	0.2707871E 02	0.1100000E 01
0.8552866E 03	0.2594453E 02	0.3886312E 02	0.1200000E 01
0.1492099E 04	0.3439505E 02	0.5962745E 02	0.1300000E 01
0.3499247E 04	0.5287286E 02	0.1051444E 03	0.1400000E 01
0.6763521E 04	0.7366725E 02	0.1561954E 03	0.1450000E 01
0.1904978E 05	0.1218900E 03	0.2602524E 03	0.1500000E 01
0.2137236E 06	0.4158491E 03	0.1000577E 04	0.1550000E 01
TENSILE END LOADS			
0.119565[illegible] 03	0.1024117E 02	0.5762945E 0[illegible]	0.3000000E 00
[illegible] 03	0.9760579E 01	0.937[illegible]068E 01	0.4000000E 00
0.1237031E 03	0.9621798E 01	0.2035409E 0[illegible]	0.5000000E 00
0.1144683E 03	0.9216783E 01	0.1025242E [illegible]	[illegible] 00
0.1064723E 03	0.8815937E 01	0.2621232E 01	0.7000000E 00
0.9497952E 02	0.8380225E 01	0.3063345E 01	0.8000000E 00
0.8550607E 02	0.7951307E 01	0.4826925E [illegible]	0.9000000E [illegible]
0.7651479E 02	0.7605077E 01	0.5963327E 01	0.1000000E 01
0.6814379E 02	0.7041268E 01	-0.7129332E 01	0.1100000E 01
0.6044089E 02	0.6612103E 01	[illegible]	0.1200000E 01
0.5351715E 02	0.6199974E 01	0.5977949E 01	0.1300000E 01
0.4727969E 02	0.5807510E 01	0.9082563E 01	0.1400000E 01
0.4172357E 02	0.5436243E 01	0.1073154E 02	0.1500000E 01
0.3680097E 02	0.5087197E 01	0.1152322E 02	0.1600000E 01
0.3245636E 02	0.4760421E 01	0.1225743E 02	0.1700000E 01
0.2863149E 02	0.4455550E 01	0.1293584E 02	0.1800000E 01
0.2526903E 02	0.4171925E 01	0.1356629E 02	0.1900000E 01
0.2231451E 02	0.3908327E 01	0.1413331E 02	0.2000000E 01
0.1971767E 02	0.3663942E 01	0.1465748E 02	0.2100000E 01
0.1743301E 02	[illegible]	0.1513749E 02	0.2200000E 01
0.1541992E 02	0.3227794E 01	0.1557503E 02	0.2300000E 01
0.1364250E 02	0.3033845E 01	0.1597172E 02	0.2400000E 01
0.1206932E 02	0.2853940E 01	0.1633685E 02	0.2500000E 01
0.1067295E 02	0.2687443E 01	0.1665713E 02	0.2600000E 01
0.9429612E 01	0.2533252E 01	0.1696741E 02	0.2700000E 01
0.8310210E 01	0.2390141E 01	0.1724027E 02	0.2800000E 01
0.7322592E 01	0.2257802E 01	0.1748513E 02	0.2900000E 01
0.6425764E 01	0.2134802E 01	0.1771322E 02	0.3000000E 01

TABLE 1.5-1 (Cont'd)

VALUES OF $\bar{\lambda}$, $\bar{y}$ AND $\bar{M}$ FOR SPECIFIED VALUES OF $\bar{T}_d$, $\bar{T}$ AND $\bar{W}$

$\bar{T}_D$ = -0.2000000E 02 $\bar{W}$ = 0.6000000E 01

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.1672762E 03	0.1125000E 02	0.3000000E 01	0.
0.1800577E 03	0.1168673E 02	0.4051806E 01	-0.3000000E-00
0.1910479E 03	0.1205003E 02	0.4928005E 01	-0.4000000E-00
0.2067329E 03	0.1255093E 02	0.6137733E 01	-0.5000000E 00
0.2286938E 03	0.1322140E 02	0.7759704E 01	-0.6000000E 00
0.2595113E 03	0.1411019E 02	0.9913993E 01	-0.7000000E 00
0.3035485E 03	0.1529320E 02	0.1278765E 02	-0.8000000E 00
0.3685983E 03	0.1689333E 02	0.1668360E 02	-0.9000000E 00
0.4696770E 03	0.1912121E 02	0.2212121E 02	-0.1000000E 01
0.6388972E 03	0.2236804E 02	0.3006533E 02	-0.1100000E 01
0.9558653E 03	0.2744373E 02	0.4252617E 02	-0.1200000E 01
0.1667749E 04	0.3658377E 02	0.6448558E 02	-0.1300000E 01
0.3911532E 04	0.5592819E 02	0.1126193E 03	-0.1400000E 01
0.7560665E 04	0.7790702E 02	0.1667995E 03	-0.1450000E 01
0.2129549E 05	0.1310087E 03	0.2977682E 03	-0.1500000E 01
0.2389217E 06	0.4396991E 03	0.1059377E 04	-0.1550000E 01
TENSILE END LOADS			
0.1558184E 03	0.1084410E 02	0.2024031E 01	0.3000000E-00
0.1477069E 03	0.1034769E 02	0.1312370E 01	0.4000000E-00
0.1381794E 03	0.1018910E 02	0.4527245E-00	0.5000000E 00
0.1277464E 03	0.9781938E 01	-0.5214976E 00	0.6000000E 00
0.1168811E 03	0.9339938E 01	-0.1576570E 01	0.7000000E 00
0.1059936E 03	0.8076075E 01	-0.2680688E 01	0.8000000E 00
0.9540917E 02	0.8401912E 01	-0.3805549E 01	0.9000000E 00
0.8536425E 02	0.7927240E 01	-0.4927240E 01	0.1000000E 01
0.7601342E 02	0.7459955E 01	-0.6026545E 01	0.1100000E 01
0.6744139E 02	0.7006113E 01	-0.7088802E 01	0.1200000E 01
0.5967826E 02	0.6570103E 01	-0.8103474E 01	0.1300000E 01
0.5271422E 02	0.6154881E 01	-0.9063566E 01	0.1400000E 01
0.4651237E 02	0.5762223E 01	-0.9965002E 01	0.1500000E 01
0.4101926E 02	0.5392973E 01	-0.1080601E 02	0.1600000E 01
0.3617275E 02	0.5047259E 01	-0.1158658E 02	0.1700000E 01
0.3190778E 02	0.4724687E 01	-0.1230799E 02	0.1800000E 01
0.2816016E 02	0.4424492E 01	-0.1297242E 02	0.1900000E 01
0.2486901E 02	0.4145665E 01	-0.1358266E 02	0.2000000E 01
0.2197814E 02	0.3883042E 01	-0.1414186E 02	0.2100000E 01
0.1943667E 02	0.3647305E 01	-0.1465335E 02	0.2200000E 01
0.1719915E 02	0.3425427E 01	-0.1512051E 02	0.2300000E 01
0.1522549E 02	0.3219911E 01	-0.1554669E 02	0.2400000E 01
0.1348049E 02	0.3029620E 01	-0.1593512E 02	0.2500000E 01
0.1193352E 02	0.2853388E 01	-0.1628890E 02	0.2600000E 01
0.1055798E 02	0.2690117E 01	-0.1661095E 02	0.2700000E 01
0.9330850E 01	0.2538774E 01	-0.1690399E 02	0.2800000E 01
0.8232254E 01	0.2398401E 01	-0.1717055E 02	0.2900000E 01
0.7245042E 01	0.2268110E 01	-0.1741299E 02	0.3000000E 01

$\bar{T}_D$ = -0.2000000E 02 $\bar{W}$ = 0.9000000E 01

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.1857048E 03	0.1187500E 02	0.4500000E 01	0.
0.1999061E 03	0.1233547E 02	0.5610192E 01	-0.3000000E-00
0.2121178E 03	0.1271852E 02	0.6534963E 01	-0.4000000E-00
0.2295461E 03	0.1324664E 02	0.7811660E 01	-0.5000000E 00
0.2539486E 03	0.1395354E 02	0.9523274E 01	-0.6000000E 00
0.2881926E 03	0.1489060E 02	0.1179640E 02	-0.7000000E 00
0.3371277E 03	0.1613786E 02	0.1482823E 02	-0.8000000E 00
0.4094143E 03	0.1782486E 02	0.1893814E 02	-0.9000000E 00
0.5217405E 03	0.2017366E 02	0.2467366E 02	-0.1000000E 01
0.7097946E 03	0.2359666E 02	0.3305195E 02	-0.1100000E 01
0.1062046E 04	0.2895293E 02	0.4619222E 02	-0.1200000E 01
0.1853184E 04	0.3837250E 02	0.6934953E 02	-0.1300000E 01
0.4346786E 04	0.5897652E 02	0.1200940E 03	-0.1400000E 01
0.8402217E 04	0.8214680E 02	0.1772136E 03	-0.1450000E 01
0.2366631E 05	0.1381262E 03	0.3152840E 03	-0.1500000E 01
0.2655237E 06	0.4635492E 03	0.1118177E 04	-0.1550000E 01
TENSILE END LOADS			
0.1729761E 03	0.1144703E 02	0.3469767E 01	0.3000000E-00
0.1639597E 03	0.1113450E 02	0.2718480E 01	0.4000000E-00
0.1533767E 03	0.1075641E 02	0.1810898E 01	0.5000000E 00
0.1417857E 03	0.1032709E 02	0.7822466E 00	0.6000000E 00
0.1297151E 03	0.9861040E 01	-0.3319093E-00	0.7000000E 00
0.1176203E 03	0.9371924E 01	-0.1496032E 01	0.8000000E 00
0.1058628E 03	0.8871918E 01	-0.2686270E 01	0.9000000E 00
0.9470569E 02	0.8371403E 01	-0.3871403E 01	0.1000000E 01
0.8432044E 02	0.7878644E 01	-0.5033159E 01	0.1100000E 01
0.7480127E 02	0.7400045E 01	-0.6156065E 01	0.1200000E 01
0.6618162E 02	0.6940235E 01	-0.7228998E 01	0.1300000E 01
0.5845054E 02	0.6502333E 01	-0.8244569E 01	0.1400000E 01
0.5156702E 02	0.6088206E 01	-0.9198463E 01	0.1500000E 01
0.4547163E 02	0.5698749E 01	-0.1008880E 02	0.1600000E 01
0.4009530E 02	0.5334097E 01	-0.1091554E 02	0.1700000E 01
0.3534571E 02	0.4993836E 01	-0.1168003E 02	0.1800000E 01
0.3121150E 02	0.4677159E 01	-0.1238454E 02	0.1900000E 01
0.2756500E 02	0.4383003E 01	-0.1303201E 02	0.2000000E 01
0.2436374E 02	0.4110143E 01	-0.1362573E 02	0.2100000E 01
0.2155116E 02	0.3857274E 01	-0.1416920E 02	0.2200000E 01
0.1907675E 02	0.3623059E 01	-0.1466598E 02	0.2300000E 01
0.1689592E 02	0.3406177E 01	-0.1511958E 02	0.2400000E 01
0.1496951E 02	0.3205144E 01	-0.1553340E 02	0.2500000E 01
0.1326363E 02	0.3019551E 01	-0.1591068E 02	0.2600000E 01
0.1174852E 02	0.2846981E 01	-0.1625449E 02	0.2700000E 01
0.1039867E 02	0.2687207E 01	-0.1656770E 02	0.2800000E 01
0.9191973E 01	0.2538998E 01	-0.1685297E 02	0.2900000E 01
0.8109364E 01	0.2401419E 01	-0.1711277E 02	0.3000000E 01

$\bar{T}_D$ = -0.2000000E 02 $\bar{W}$ = 0.1200000E 02

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.2031048E 03	0.1250000E 02	0.6000000E 01	0.
0.2208005E 03	0.1298421E 02	0.7168579E 01	-0.3000000E 00
0.2342987E 03	0.1338701E 02	0.8141921E 01	-0.4000000E-00
0.2535672E 03	0.1394215E 02	0.9485587E 01	-0.5000000E 00
0.2805347E 03	0.1468567E 02	0.1128684E 02	-0.6000000E 00
0.3181844E 03	0.1567102E 02	0.1367680E 02	-0.7000000E 00
0.3724779E 03	0.1698252E 02	0.1688081E 02	-0.8000000E 00
0.4573853E 03	0.1873619E 02	0.2119268E 02	-0.9000000E 00
0.5765504E 03	0.2122610E 02	0.2722610E 02	-0.1000000E 01
0.7844321E 03	0.2482527E 02	0.3603858E 02	-0.1100000E 01
0.1171829E 04	0.3045711E 02	0.4958827E 02	-0.1200000E 01
0.2048405E 04	0.4036123E 02	0.7421047E 02	-0.1300000E 01
0.4805007E 04	0.6202485E 02	0.1275637E 03	-0.1400000E 01
0.9208180E 04	0.8438657E 02	0.1876213E 03	-0.1450000E 01
0.2616225E 05	0.1452453E 03	0.3327495E 03	-0.1500000E 01
0.2935294E 06	0.4873995E 03	0.1176477E 04	-0.1550000E 01
TENSILE END LOADS			
0.1910388E 03	0.1204996E 02	0.4915503E 01	0.3000000E 00
0.1810712E 03	0.1172135E 02	0.4124590E 01	0.4000000E 00
0.1693749E 03	0.1132371E 02	0.3169071E 01	0.5000000E 00
0.1565650E 03	0.1087225E 02	0.2085991E 01	0.6000000E 00
0.1432252E 03	0.1038214E 02	0.9127511E 00	0.7000000E 00
0.1298594E 03	0.9867774E 01	-0.3153750E 00	0.8000000E 00
0.1168672E 03	0.9341984E 01	-0.1586491E 01	0.9000000E 00
0.1045391E 03	0.8815565E 01	-0.2815566E 01	0.1000000E 01
0.9304484E 02	0.8297333E 01	-0.4039772E 01	0.1100000E 01
0.8254059E 02	0.7793978E 01	-0.5223128E 01	0.1200000E 01
0.7302727E 02	0.7310168E 01	-0.6354522E 01	0.1300000E 01
0.6448465E 02	0.6849782E 01	-0.7425572E 01	0.1400000E 01
0.5688751E 02	0.6414109E 01	-0.8431925E 01	0.1500000E 01
0.5015808E 02	0.6004525E 01	-0.9371584E 01	0.1600000E 01
0.4422399E 02	0.5620935E 01	-0.1024450E 02	0.1700000E 01
0.3900528E 02	0.5262904E 01	-0.1105207E 02	0.1800000E 01
0.3442305E 02	0.4929025E 01	-0.1179667E 02	0.1900000E 01
0.3040247E 02	0.4620540E 01	-0.1248116E 02	0.2000000E 01
0.2687444E 02	0.4333244E 01	-0.1310480E 02	0.2100000E 01
0.2377449E 02	0.4067162E 01	-0.1368506E 02	0.2200000E 01
0.2105271E 02	0.3820692E 01	-0.1421146E 02	0.2300000E 01
0.1865381E 02	0.3592463E 01	-0.1469747E 02	0.2400000E 01
0.1653456E 02	0.3381067E 01	-0.1511167E 02	0.2500000E 01
0.1466327E 02	0.3185278E 01	-0.1553245E 02	0.2600000E 01
0.1300128E 02	0.3003848E 01	-0.1589803E 02	0.2700000E 01
0.1152223E 02	0.2835640E 01	-0.1623141E 02	0.2800000E 01
0.1020175E 02	0.2679595E 01	-0.1653359E 02	0.2900000E 01
0.9018730E 01	0.2534727E 01	-0.1681255E 02	0.3000000E 01

$\bar{T}_D$ = 0.2000000E 02 $\bar{W}$ = 0.1500000E 02

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.2254762E 03	0.1312500E 02	0.7500000E 01	0.
0.2427416E 03	0.1361290E 02	0.8726966E 01	-0.3000000E 00
0.2575902E 03	0.1405549E 02	0.9740817E 01	-0.4000000E 00
0.2787810E 03	0.1463406E 02	0.1115951E 02	-0.5000000E 00
0.3084525E 03	0.1541781E 02	0.1305041E 02	-0.6000000E 00
0.3500926E 03	0.1645144E 02	0.1556120E 02	-0.7000000E 00
0.4095990E 03	0.1782216E 02	0.1890919E 02	-0.8000000E 00
0.4975047E 03	0.1968792E 02	0.2344722E 02	-0.9000000E 00
0.6341066E 03	0.2227855E 02	0.2977455E 02	-0.1000000E 01
0.8628090E 03	0.2605590E 02	0.3902520E 02	-0.1100000E 01
0.1291215E 04	0.3196133E 02	0.5552432E 02	-0.1200000E 01
0.2255407E 04	0.4234995E 02	0.7907142E 02	-0.1300000E 01
0.5206197E 04	0.6507318E 02	0.1350435E 03	-0.1400000E 01
0.1021855E 05	0.9062654E 02	0.1980419E 03	-0.1450000E 01
0.2078329E 05	0.1523625E 03	0.3503155E 03	-0.1500000E 01
0.3229391E 06	0.5112424E 03	0.1235277E 04	-0.1550000E 01
TENSILE END LOADS			
0.2100068E 03	0.1245259E 02	0.6161239E 01	0.3000000E 00
0.1990394E 03	0.1210312E 02	0.5530720E 01	0.4000000E 00
0.1861740E 03	0.1169102E 02	0.4527245E 01	0.5000000E 00
0.1720840E 03	0.1121740E 02	0.3169735E 01	0.6000000E 00
0.1574116E 03	0.1070124E 02	0.2257411E 01	0.7000000E 00
0.1427111E 03	0.1015162E 02	0.8612816E 00	0.8000000E 00
0.1284223E 03	0.9611990E 01	-0.4477114E 00	0.9000000E 00
0.1148645E 03	0.9254775E 01	-0.1759229E 01	0.1000000E 01
0.1022467E 03	0.8718021E 01	-0.3046385E 01	0.1100000E 01
0.9048334E 02	0.8187910E 01	-0.4292591E 01	0.1200000E 01
0.8021500E 02	0.7680501E 01	-0.5482047E 01	0.1300000E 01
0.7082055E 02	0.7197232E 01	-0.6608575E 01	0.1400000E 01
0.6247184E 02	0.6740172E 01	-0.7665358E 01	0.1500000E 01
0.5507860E 02	0.6310301E 01	-0.8655437E 01	0.1600000E 01
0.4855983E 02	0.5907774E 01	-0.9571466E 01	0.1700000E 01
0.4282650E 02	0.5532113E 01	-0.1042411E 02	0.1800000E 01
0.3779481E 02	0.5182492E 01	-0.1120840E 02	0.1900000E 01
0.3338142E 02	0.4857628E 01	-0.1193071E 02	0.2000000E 01
0.2951031E 02	0.4556345E 01	-0.1259548E 02	0.2100000E 01
0.2611265E 02	0.4277050E 01	-0.1320092E 02	0.2200000E 01
0.2312704E 02	0.4018324E 01	-0.1375493E 02	0.2300000E 01
0.2049915E 02	0.3778710E 01	-0.1424537E 02	0.2400000E 01
0.1818145E 02	0.3556791E 01	-0.1472995E 02	0.2500000E 01
0.1611245E 02	0.3351217E 01	-0.1515425E 02	0.2600000E 01
0.1431619E 02	0.3160710E 01	-0.1555158E 02	0.2700000E 01
0.1270153E 02	0.2984072E 01	-0.1589513E 02	0.2800000E 01
0.1126150E 02	0.2820191E 01	-0.1621781E 02	0.2900000E 01
0.9973140E 01	0.2668036E 01	-0.1651232E 02	0.3000000E 01

TABLE 1.5-1 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{W}$

$\overline{T}_D$ = -0.2000000E 02 $\overline{W}$ = 0.1800000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.2468190E 03	0.1375000E 02	0.9000000E 01	0.
0.2657294E 03	0.1428170E 02	0.1028555E 02	0.3000000E 00
0.2819924E 03	0.1472398E 02	0.1135584E 02	0.4000000E 00
0.3052027E 03	0.1533376E 02	0.1293364E 02	0.5000000E 00
0.3377020E 03	0.1614995E 02	0.1491[illegible]E 02	0.6000000E 00
0.3833112E 03	0.1723385E 02	0.1744561E 02	0.7000000E 00
0.4484909E 03	0.1867184E 02	0.2094229E 02	0.8000000E 00
0.5447790E 03	0.2061945E 02	0.2573177E 02	-0.9000000E 00
0.6944091E 03	0.2333100E 02	0.323[illegible]E 02	0.1000000E 01
0.9449277E 03	0.2720250E 02	0.4221182E 02	0.1100000E 01
0.1414202E 04	0.3396553E 02	0.5733036E 02	0.1200000E 01
0.2468195E 04	0.4433868E 02	0.8332347E 02	0.1300000E 01
0.5790354E 04	0.6812152E 02	0.1425142E 03	0.1400000E 01
0.1119333E 05	0.9486611E 02	0.2044560E 03	0.1450000E 01
0.3152945E 05	0.1594806E 03	0.3475311E 03	0.1500000E 01
0.3553752E 06	0.5550925E 03	0.1226577E 04	0.1550000E 01
TENSILE END LOADS			
0.2298[illegible]E 03	0.1325582E 02	[illegible]	[illegible]
0.2178[illegible]E 03	0.1289[illegible]E 02	0.67[illegible]E 01	[illegible]
0.2037[illegible]E 03	0.1255933E 02	0.54[illegible]E 01	[illegible]
0.1885[illegible]E 03	0.1196256E 02	[illegible]	[illegible]
0.1722[illegible] 03	0.1152[illegible]E 02	[illegible]	[illegible]
0.1561756E 03	0.1085947E 02	[illegible]	[illegible]
0.1405278E 03	0.1024202E 02	0.6715575E [illegible]	[illegible]
0.1255818E 03	0.972[illegible]E 01	0.7[illegible]E [illegible]	[illegible]
0.1113659E 03	[illegible]	[illegible]	[illegible]
0.9720555E 02	0.858[illegible]E 01	[illegible]	[illegible]
0.8477[illegible]E 02	0.805[illegible]E 01	[illegible]	[illegible]
0.7247025E 02	0.75[illegible]E 01	[illegible]	[illegible]
0.683[illegible]E 02	0.7[illegible]E 01	[illegible]	[illegible]
0.6023[illegible] 02	0.6615[illegible]E 01	[illegible]	[illegible]
[illegible] 02	0.61[illegible]E 01	[illegible]	[illegible]
[illegible] 02	[illegible]	[illegible]	[illegible]
[illegible] 02	[illegible]	[illegible]	[illegible]
0.3650[illegible] 02	[illegible]	[illegible]	[illegible]
[illegible] 02	[illegible]	[illegible]	[illegible]
[illegible] 02	[illegible]	[illegible]	[illegible]
[illegible] 02	[illegible]	[illegible]	[illegible]
[illegible] 02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible] 02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] 01	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible] 02	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = -0.2000000E 02 $\overline{W}$ = 0.2100000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.2621353E 03	0.14[illegible]E 02	0.1050000E 02	0.
0.2897623E 03	[illegible] 02	0.1146374E 02	0.1000000E-00
0.3075057E 03	0.1539217E 02	0.1296249E 02	-0.4000000E-00
0.3328272E 03	0.1622947E 02	0.1450737E 02	0.5000000E 00
0.3682830E 03	0.1788204E 02	0.1657755E 02	0.6000000E 00
0.4180423E 03	0.1801227E 02	0.1932601E 02	-0.7000000E 00
0.4891537E 03	0.1951650E 02	0.2299056E 02	0.8000000E 00
0.5[illegible]2062E 03	0.2155998E 02	0.2795630E 02	0.9000000E 00
0.7574585E 03	0.2635364E 02	0.3688364E 02	0.1000000E 01
0.1131748E 04	0.2851[illegible]E 02	0.4999446E 02	0.11[illegible]E 01
0.1567792E 04	0.3698975E 02	0.6295664E 02	0.12[illegible]E 01
0.2672788E 04	0.4752[illegible]E 02	0.8879332E 02	0.13[illegible]E 01
0.6317480E 04	0.7112985E 02	0.1699272E 03	0.14[illegible]E 01
0.1221252E 05	0.2915[illegible]E 02	0.2188701E 03	0.145[illegible]E 01
0.3450072E 05	0.1658947E 03	0.3455671E 03	0.15[illegible]E 01
0.3859692E 06	0.5580499E 03	[illegible] 04	0.155[illegible]E 01
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = [illegible] $\overline{W}$ = [illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-2

VALUES OF $\bar{\lambda}$, $\bar{y}$ AND $\bar{M}$ FOR SPECIFIED VALUES OF $\bar{T}_d$, $\bar{T}$ AND $\bar{Q}$

(Pages 1.38 through 1.55)

TABLE 1.5-2 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = 0. $\overline{Q}$ = 0.

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.	0.	0.	0.
0.1500000E-01	0.	0.	-0.3000000E-00
0.2666667E-01	0.	0.	-0.4000000E 00
0.4166667E-01	0.	0.	-0.5000000E 00
0.6000000E-01	0.	0.	-0.6000000E 00
0.8166666E-01	0.	0.	-0.7000000E 00
0.1066667E-00	0.	0.	-0.8000000E 00
0.1350000E-00	0.	0.	-0.9000000E 00
0.1666667E-00	0.	0.	-0.1000000E 01
0.2016667E-00	0.	0.	-0.1100000E 01
0.2400000E-00	0.	0.	-0.1200000E 01
0.2816667E-00	0.	0.	-0.1300000E 01
0.3266667E-00	0.	0.	0.1400000E 01
0.3504167E-00	0.	0.	-0.1450000E 01
0.3750000E-00	0.	0.	-0.1500000E 01
0.4004167E-00	0.	0.	-0.1550000E 01
TENSILE END LOADS			
-0.1500000E-01	0.	0.	0.3000000E-00
-0.2666667E 01	0.	0.	0.4000000E 00
-0.4166667E 01	0.	0.	0.5000000E 00
-0.6000000E-01	0.	0.	0.6000000E 00
0.8166666E-01	0.	0	0.7000000E 00
-0.1066667E 00	0.	0.	0.8000000E 00
0.1350000E-00	0.	0.	0.9000000E 00
0.1666667E-00	0.	0.	0.1000000E 01
-0.2016667E-00	0.	0.	0.1100000E 01
0.2400000E 00	0.	0.	0.1200000E 01
0.2816667E 00	0.	0.	[illegible]
-0.3266667E-00	0.	0.	0.1400000E 01
-0.3750000E-00	0.	0.	0.1500000E 01
0.4266667E 00	0.	0.	[illegible]
-0.4816667E 00	0.	0.	[illegible]
0.5400000E 00	0.	0.	[illegible]
0.6016667E 00	0.	0.	[illegible]
0.6666667E 00	0.	0.	[illegible]
0.7350000E 00	0.	0.	[illegible]
-0.8066666E 00	0.	0.	0.2200000E 01
0.8816666E 00	0.	0.	0.2300000E 01
-0.9600000E 00	0.	0.	[illegible]
0.1041667E 01	0.	0.	[illegible]
-0.1126667E 01	0.	0.	[illegible]
-0.1215000E 01	0.	0.	[illegible]
0.1306667E 01	0.	0.	[illegible]
[illegible]	0.	0.	[illegible]
0.1500000E 01	0.	0.	[illegible]

$\overline{T}_D$ = 0. $\overline{Q}$ = 0.3000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1200000E 01	0.1000000E 01	0.3000000E 01	0.
0.1307466E 01	0.1037361E 01	0.3095562E 01	-0.3000000E-00
0.1398629E 01	0.1068432E 01	0.3172949E 01	-0.4000000E 00
0.1527135E 01	0.1111260E 01	0.3277815E 01	-0.5000000E 00
0.1704416E 01	0.1168567E 01	0.3420684E 01	-0.6000000E 00
0.1949192E 01	0.1244525E 01	0.3609837E 01	-0.7000000E 00
0.2293067E 01	0.1345538E 01	0.3861144E 01	-0.8000000E 00
0.2792554E 01	0.1482133E 01	0.4200527E 01	-0.9000000E 00
0.3556497E 01	0.1672223E 01	0.4672223E 01	-0.1000000E 01
0.4017673E 01	0.1949120E 01	0.5358455E 01	0.1100000E 01
0.7155161E 01	0.2382208E 01	0.6453179E 01	-0.1200000E 01
0.1235466E 02	0.3143517E 01	0.8312544E 01	-0.1300000E 01
0.2866417E 02	0.4808192E 01	0.1242404E 02	-0.1400000E 01
0.5540012E 02	0.6672023E 01	0.1704453E 02	-0.1450000E 01
0.1547281E 03	0.1120126E 02	0.2872284E 02	-0.1500000E 01
0.1732325E 04	0.3748122E 02	0.9305512E 02	0.1550000E 01
TENSILE END LOADS			
0.1102102E 01	0.9652650E 00	0.2913226E 01	0.3000000E 00
0.1031814E 01	0.9378925E 00	0.2842617E 01	0.4000000E 00
0.9472958E 00	0.9091484E 00	0.2772703E 01	0.5000000E 00
0.8562311E 00	0.8745116E 00	0.2685268E 01	0.6000000E 00
0.7540841E 00	0.8386335E 00	0.2590146E 01	0.7000000E 00
0.5524810E 00	0.7966596E 00	0.2490113E 01	[illegible]
0.5457805E 00	[illegible]	0.2187660E 01	[illegible]
[illegible]	[illegible]	0.2298282E 01	[illegible]
[illegible]	[illegible]	0.2193179E 01	[illegible]
[illegible]	[illegible]	0.2096135E 01	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.5626622E 00	0.1897182E 01	[illegible]
[illegible]	[illegible]	0.1813228E 01	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = 0. $\overline{Q}$ = [illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	0.
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = 0. $\overline{Q}$ = [illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	0.
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-2 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = 0. $\overline{Q}$ = 0.12000000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.19200000E 02	0.40000000E 01	0.12000000E 02	0.
0.20694445E 02	0.41493444E 01	0.12373455E 02	-0.10000000E-00
0.21975068E 02	0.42737708E 01	0.12683808E 02	-0.40000000E-00
0.23809166E 02	0.44450588E 01	0.13111126E 02	-0.50000000E 00
0.26370658E 02	0.46742668E 01	0.13682773E 02	0.60000000E 00
0.29981926E 02	0.49780196E 01	0.14439270E [illegible]	-0.70000000E 00
0.35089078E 02	0.53421538E 01	0.15448458E 02	-0.80000000E 00
0.42655868E 02	0.59285308E 01	0.16802718E 02	0.90000000E 00
0.54403968E 02	0.66888938E 01	0.18688898E 02	-0.10000000E 01
0.74057868E 02	0.77964818E 01	0.21433748E 02	-0.11000000E 01
0.11085068E 03	0.95288408E 01	0.25721518E 02	0.12000000E 01
0.19344968E 03	0.12574078E 02	0.33250188E 02	0.13000000E 01
0.45372688E 03	0.19232738E 02	0.49695148E 02	0.14000000E 01
0.87698578E 03	0.26719298E 02	0.68177318E 02	0.14500000E 01
0.24700248E 04	0.44805058E 02	0.11251148E 03	0.15000000E 01
0.27711208E 05	0.14993578E 03	0.37222058E 03	-0.15500000E 01
TENSILE END LOADS			
0.17858064E 02	0.38610600E 01	0.11652508E 02	0.30000000E 00
0.16909028E 02	0.37595708E 01	0.11394878E 02	0.40000000E 00
0.15792348E 02	0.36367548E 01	0.11090818E 02	0.50000000E 00
0.14556770E 02	0.34972468E 01	0.10749998E 02	0.60000000E 00
0.13290348E 02	0.33457348E 01	0.10360598E 02	0.70000000E 00
0.12007708E 02	0.31866588E 01	0.99605558E 01	0.80000000E 00
0.10757498E 02	0.30239058E 01	0.95508648E 01	0.90000000E 00
0.95871548E 01	0.28608708E 01	0.91591308E 01	0.10000000E 01
0.84545708E 01	0.27002348E 01	0.87127158E 01	0.11000000E 01
0.74295638E 01	0.25440658E 01	0.83165468E 01	0.12000000E 01
0.64956068E 01	0.23938658E 01	0.77543688E 01	0.13000000E 01
0.56515368E 01	0.22506498E 01	0.75687288E 01	0.14000000E 01
0.49910558E 01	0.21150248E 01	0.72411868E 01	0.15000000E 01
0.42139418E 01	0.19872298E 01	0.69124148E 01	0.16000000E 01
0.36067748E 01	0.18675138E 01	0.66028988E 01	0.17000000E 01
0.30445838E 01	0.17555438E 01	0.63120408E 01	0.18000000E 01
0.25743108E 01	0.16511378E 01	0.60395948E 01	0.19000000E 01
0.21440758E 01	0.15539598E 01	0.57841658E 01	0.20000000E 01
0.17521408E 01	0.14636128E 01	0.55454058E 01	0.21000000E 01
0.13902038E 01	0.13797038E 01	0.53222358E 01	0.22000000E 01
0.10761658E 01	0.13011878E 01	0.51131448E 01	0.23000000E 01
0.78216748E 00	0.12229448E 01	0.49183748E 01	0.24000000E 01
0.51151528E 00	[illegible] 01	0.47357498E 01	0.25000000E 01
0.26384408E-00	0.10998908E 01	0.45554748E 01	0.26000000E 01
0.27066988E-01	0.10419108E 01	0.44034770E 01	0.27000000E 01
0.19250278E 00	0.98799108E 00	0.42561158E 01	0.28000000E 01
0.40017548E-30	0.93741408E 00	0.41129518E 01	0.29000000E 01
0.59794508E 00	0.89106498E 00	0.39802148E 01	0.30000000E 01

$\overline{T}_D$ = 0. $\overline{Q}$ = 0.15000000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.33300000E 02	0.50000000E 01	0.15000000E 02	0.
0.35232668E 02	0.51858058E 01	0.15466818E 02	-0.10000000E-00
0.34325728E 02	0.53421608E 01	0.15858758E 02	-0.40000000E 00
0.37178388E 02	0.55562948E 01	0.16349078E 02	-0.50000000E 00
0.41170398E 02	0.58629338E 01	0.17131428E 02	0.60000000E 00
0.46769568E 02	0.62252448E 01	0.19042348E 02	-0.70000000E 00
0.54766668E 02	0.67276928E 01	0.19305728E 02	-0.80000000E 00
0.56573848E 02	0.74106638E 01	0.21002448E 02	-0.90000000E 00
0.84912438E 02	0.83441168E 01	0.23361128E 02	0.10000000E 01
0.11562208E 03	0.97455168E 01	0.26792128E 02	0.11000000E 01
0.17106908E 03	0.11711068E 02	0.32151898E 02	-0.12000000E 01
0.32210668E 03	0.15717598E 02	0.41562728E 02	-0.13000000E 01
0.70876448E 03	0.24042918E 02	0.62122148E 02	0.14000000E 01
0.13710938E 04	[illegible] 02	0.45221648E 02	0.14500000E 01
0.38592028E [illegible]	0.56306418E 02	0.14101428E 03	0.15000000E 01
0.43298538E 05	0.18741268E 03	0.46527548E 03	0.15500000E 01
TENSILE END LOADS			
0.27912568E 02	0.49255258E 01	0.14565638E 02	0.30000000E 00
0.26435358E 02	0.46992468E 01	0.14248070E 02	0.40000000E 00
0.24698978E 02	0.45457628E 01	0.13863518E 02	0.50000000E 00
0.22795798E 02	0.43715598E 01	0.13462848E 02	0.60000000E 00
0.20912108E 02	0.41821678E 01	0.12950748E 02	0.70000000E 00
0.18822028E 02	0.39932998E 01	0.12453698E 02	0.80000000E 00
0.16884518E 02	0.37798798E 01	[illegible] 02	[illegible]
0.15042438E 02	0.35763088E 01	0.11621271E 02	0.10000000E 01
0.13323708E 02	0.33752238E 01	0.11291549E 02	0.11000000E 01
0.11763698E 02	[illegible] 01	0.10427498E 02	0.12000000E 01
0.10307828E 02	0.29923328E 01	0.99424591E 01	0.13000000E 01
0.92142758E 01	0.28133318E 01	0.94859758E 01	0.14000000E 01
0.78563368E 01	0.26437858E 01	0.90551683E 01	0.15000000E 01
0.68262838E 01	0.24851248E 01	0.85404438E 01	0.16000000E 01
0.59068348E 01	0.23364918E 01	[illegible] 01	0.17000000E 01
0.50921628E 01	[illegible] 01	0.78420508E 01	0.18000000E 01
[illegible] 01	0.20632228E 01	[illegible]	0.19000000E 01
[illegible] 01	0.19428441E 01	[illegible]	0.20000000E 01
[illegible]	0.18295548E 01	[illegible]	0.21000000E 01
0.25584428E 01	0.17265228E 01	0.65522288E 01	0.22000000E 01
[illegible] 01	[illegible]	[illegible] 01	[illegible]
0.17821338E 01	[illegible]	[illegible] 01	[illegible]
[illegible] 01	[illegible]	0.59195808E 01	[illegible]
0.10418258E 01	[illegible]	0.57057278E 01	[illegible]
0.72572908E 00	[illegible]	[illegible]	[illegible]
[illegible] 00	[illegible]	[illegible]	[illegible]
0.15316298E 00	[illegible]	[illegible]	[illegible]
0.72560018E-01	[illegible]	[illegible] 01	[illegible]

$\overline{T}_D$ = 0.40000000E 01 $\overline{Q}$ = [illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.53333333E 01	0.40000000E 01	0.	0.
0.57545871E 01	[illegible]	[illegible] 02	0.10000000E [illegible]
0.61152208E 01	[illegible] 01	0.35281778E 02	0.40000000E [illegible]
0.64285938E 01	[illegible] 01	[illegible]	0.50000000E [illegible]
0.73447818E 01	[illegible]	0.64453778E 02	0.60000000E 00
0.81652408E 01	0.25095813E 01	[illegible] 01	0.70000000E 00
0.97705048E 01	0.27207708E 01	[illegible] 01	0.80000000E 00
0.11860588E 02	0.30282558E 01	[illegible] 01	0.90000000E 0
0.15111158E 02	0.34091258E 01	[illegible] 01	0.10000000E 01
0.20526858E 02	[illegible] 01	[illegible] 01	0.11000000E 01
0.30642408E 02	0.43590658E 01	[illegible] 01	0.12000000E 01
0.51319748E 02	0.48612641E 01	[illegible] 02	0.13000000E 01
0.12421098E 03	0.77465068E 01	[illegible] 02	0.14000000E 01
0.24216798E 03	[illegible] 02	[illegible] 02	0.14500000E 01
0.61752748E 03	[illegible] 02	0.52562111E 02	0.15000000E 01
0.73975598E 04	0.18192798E 02	0.18041158E 03	[illegible]
TENSILE END LOADS			
0.49563611E 01	0.19213448E 01	[illegible] 02	[illegible]
0.44553138E 01	0.18748148E 01	[illegible] 02	[illegible]
0.41479238E 01	0.18108898E 01	0.45272458E 02	[illegible]
0.40174658E 01	0.17333248E 01	0.42547871E 02	[illegible]
0.34512748E 01	0.16597471E 01	[illegible]	[illegible]
0.32007188E 01	0.15748578E 01	[illegible] 01	[illegible]
0.27145478E 01	0.14821721E 01	[illegible] 01	[illegible]
0.25462928E 01	[illegible]	[illegible] 01	[illegible] 01
0.22348638E 01	0.11245758E 01	[illegible] 01	0.11000000E 01
0.19240578E 01	0.12470928E 01	[illegible] 01	0.12000000E 01
0.16875328E 01	0.11658472E 01	[illegible] 01	[illegible]
0.13752298E 01	0.10919968E 01	0.21481128E 01	0.14000000E 01
0.11200828E 01	0.10322851E 01	0.22078108E 01	0.15000000E 01
0.90127218E 00	0.99420818E 00	0.24402878E 01	0.16000000E 01
0.69544278E 00	0.88471158E 00	0.25597518E 01	0.17000000E 01
0.50307408E 00	0.81121178E 00	0.27112758E 01	0.18000000E 01
0.32442448E 00	0.78381178E 00	0.28278338E 01	0.19000000E 01
0.15605978E 00	0.71414208E 00	[illegible] 01	0.20000000E 01
0.23271248E 00	0.68814828E 00	[illegible] 01	0.21000000E 01
0.15278181E 00	0.64552188E 00	[illegible] 01	0.22000000E 01
0.29681828E 00	[illegible] 00	[illegible] 01	[illegible]
0.45572121E 00	[illegible] 00	[illegible] 01	[illegible]
0.57055828E 00	-0.55561448E 00	[illegible] 01	0.25000000E 01
0.72212508E 00	[illegible] 00	[illegible] 01	[illegible]
0.81169238E 00	[illegible] 00	[illegible] 01	[illegible] 01
0.95992088E 00	[illegible] 00	[illegible] 01	[illegible] 01
0.11072028E 01	[illegible] 00	[illegible] 01	[illegible] 01
0.12118119E 01	[illegible] 00	[illegible] 01	[illegible] 01

$\overline{T}_D$ = 0.40000000E 01 $\overline{Q}$ = [illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-2 (Cont'd)

VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = 0.4000000E 01 $\overline{Q}$ = 0.6000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1333334E-00	0.	0.6000000E 01	0.
0.1501378E-00	-0.3127247E-02	0.5999718E 01	-0.3000000E-00
0.1631953E-00	-0.5746931E-02	0.5999080E 01	-0.4000000E-00
0.1801952E-00	-0.9383678E-02	0.5997654E 01	-0.5000000E 00
0.2011312E-00	-0.1429248E-01	0.5994855E 01	-0.6000000E 00
0.2262087E-00	-0.2086210E-01	0.5989777E 01	-0.7000000E 00
0.2557339E-00	-0.2969959E-01	0.5980292E 01	-0.8000000E 00
0.2902143E-00	-0.4175828E-01	0.5966151E 01	-0.9000000E 00
0.3306392E-00	-0.5881658E-01	0.5941187E 01	-0.1000000E 01
0.3791027E-00	-0.8392289E-01	0.5898453E 01	-0.1100000E 01
0.4407716E-00	-0.1236503E-00	0.5821976E 01	-0.1200000E 01
0.5316390E 00	-0.1942298E-00	0.5671251E 01	-0.1300000E 01
0.7251785E 00	-0.3499427E-00	0.5314112E 01	-0.1400000E 01
0.9865961E 00	-0.5758496E 00	0.4894401E 01	-0.1450000E 01
0.1900412E 01	-0.9518454E 00	[illegible]	-0.1500000E 01
0.1598489E 02	-0.3431954E 01	-0.2245272E 01	-0.1550000E 01
TENSILE END LOADS			
0.1165447E-00	0.2881598E-02	0.5999741E 01	0.3000000E-00
0.1037686E-00	0.4973371E-02	0.5999205E 01	0.4000000E-00
0.8724054E-01	0.7478952E-02	0.5998130E 01	0.5000000E 00
0.6712384E-01	0.1029756E-01	0.5996293E 01	0.6000000E 00
0.4540784E-01	0.1331762E-01	0.5993473E 01	0.7000000E 00
0.3634218E-01	0.1644374E-01	0.5989476E 01	0.8000000E 00
-0.1427810E-01	0.1957957E-01	0.5984140E 01	0.9000000E 00
-0.4834370E-01	0.2265216E-01	0.5977348E 01	0.1000000E 01
-0.8583544E-01	0.2560166E-01	0.5969022E 01	0.1100000E 01
-0.1267342E-00	0.2838302E-01	0.5959128E 01	0.1200000E 01
-0.1710223E-00	0.3096521E-01	0.5947662E 01	0.1300000E 01
-0.2186903E-00	0.3337843E-01	0.5934676E 01	0.1400000E 01
-0.2697262E-00	0.3546227E-01	0.5920239E 01	0.1500000E 01
-0.3241214E-00	0.3736550E-01	0.5904344E 01	0.1600000E 01
-0.3818665E-00	[illegible]	0.5887174E 01	0.1700000E 01
-0.4429545E-00	[illegible]	0.5868800E 01	0.1800000E 01
-0.5073766E 00	0.4173676E-01	0.5849330E 01	0.1900000E 01
-0.5751264E 00	0.4278154E-01	0.5828874E 01	0.2000000E 01
-0.6461962E 00	0.4364131E-01	0.5807542E 01	0.2100000E 01
-0.7205805E 00	0.4432990E-01	0.5785443E 01	0.2200000E 01
-0.7982724E 00	0.4486116E-01	0.5762684E 01	0.2300000E 01
-0.8792659E 00	0.4524871E-01	0.5739367E 01	0.2400000E 01
-0.9635562E 00	0.4550570E-01	0.5715589E 01	0.2500000E 01
-0.1051138E 01	0.4564464E-01	0.5691442E 01	0.2600000E 01
-0.1142007E 01	0.4567735E-01	0.5667012E 01	0.2700000E 01
-0.1236160E 01	0.4561488E-01	0.5642379E 01	0.2800000E 01
-0.1333592E 01	0.4546749E-01	0.5617618E 01	0.2900000E 01
-0.1434307E 01	0.4524467E-01	0.5592799E 01	0.3000000E 01

$\overline{T}_D$ = 0.4000000E 01 $\overline{Q}$ = 0.9000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1133333E 01	0.1000000E 01	0.9000000E 01	0.
0.1225411E 01	0.1034234E 01	0.9093081E 01	-0.3000000E-00
0.1303070E 01	0.1062685E 01	0.9170029E 01	-0.4000000E-00
0.1412402E 01	0.1101876E 01	0.9275469E 01	-0.5000000E 00
0.1562553E 01	0.1154274E 01	0.9415539E 01	-0.6000000E 00
0.1768940E 01	0.1223643E 01	0.9599585E 01	-0.7000000E 00
0.2057546E 01	0.1315639E 01	0.9842137E 01	-0.8000000E 00
0.2474670E 01	0.1440344E 01	0.1016668E 02	-0.9000000E 00
0.3109679E 01	0.1613407E 01	0.1061341E 02	-0.1000000E 01
0.4153426E 01	0.1865197E 01	0.1125689E 02	-0.1100000E 01
0.6079242E 01	0.2258557E 01	0.1225732E 02	-0.1200000E 01
0.1035658E 02	0.2949287E 01	0.1398429E 02	-0.1300000E 01
0.2374490E 02	0.4458239E 01	0.1773815E 02	-0.1400000E 01
0.4546507E 02	0.6153974E 01	0.2193873E 02	-0.1450000E 01
0.1271461E 03	0.1024942E 02	0.3206119E 02	-0.1500000E 01
0.1420973E 04	0.3405191E 02	0.9080984E 02	-0.1550000E 01
TENSILE END LOADS			
0.1048953E 01	0.9681465E 00	0.8912867E 01	0.3000000E-00
0.9885891E 00	0.9448639E 00	0.8848822E 01	0.4000000E-00
0.9159859E 00	0.9166673E	0.8770333E 01	0.5000000E 00
0.8344366E 00	0.8846091E	0.8681540E 01	0.6000000E 00
0.7468442E 00	0.8497530E 00	0.8583421E 01	0.7000000E 00
0.6555972E 00	0.8131033E 00	0.8479614E 01	0.8000000E 00
0.5626506E 00	0.7755554E 00	0.8371800E 01	0.9000000E 00
0.4694298E-00	[illegible]	0.8262130E 01	0.1000000E 01
0.3768601E-00	0.7006602E 00	0.8152701E 01	0.1100000E 01
0.2854636E-00	0.6643993E 00	0.8043245E 01	0.1200000E 01
0.1954390E-00	0.6294315E 00	0.7936261E 01	0.1300000E 01
0.1067305E-00	0.5959207E 00	0.7831958E 01	0.1400000E 01
0.1915901E-01	0.5642198E 00	0.7730505E 01	0.1500000E 01
-0.6760323E-01	0.5341903E 00	0.7632473E 01	0.1600000E 01
-0.1539009E-00	0.5059182E 00	0.7537976E 01	0.1700000E 01
-0.2401095E-00	0.4793795E-00	0.7446910E 01	0.1800000E 01
-0.3265941E-00	0.4545211E-00	[illegible]	0.1900000E 01
-0.4137051E-00	0.4312712E 00	0.7274915E 01	0.2000000E 01
-0.5017632E 00	0.4095461E 00	0.7193272E 01	0.2100000E 01
-0.5910618E 00	0.3922559E 00	0.7116002E 01	0.2200000E 01
-0.6818587E 00	0.3703079E 00	0.7041971E 01	0.2300000E 01
-0.7743818E 00	0.3526109E 00	0.6969761E 01	0.2400000E 01
-0.8688337E 00	0.3360757E-00	0.6892526E 01	0.2500000E 01
-0.9653861E 00	0.3206172E-00	0.6832628E 01	0.2600000E 01
-0.1066193E 01	0.3063548E-00	0.6768131E 01	0.2700000E 01
-0.1165387E 01	0.2926131E 00	0.6705913E 01	0.2800000E 01
-0.1269068E 01	0.2799223E-00	0.6655556E 01	0.2900000E 01
-0.1375349E 01	[illegible]	0.6587052E 01	0.3000000E 01

$\overline{T}_D$ = 0.4000000E 01 $\overline{Q}$ = 0.1200000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.4533333E 01	0.2000000E 01	0.1200000E 02	0.
0.4885615E 01	0.2071595E 01	0.1218644E 02	-0.3000000E 00
0.5186369E 01	0.2131117E 01	0.1234098E 02	-0.4000000E 00
0.5615545E 01	0.2213335E 01	0.1255328E 02	-0.5000000E 00
0.6212806E 01	0.2322841E 01	0.1283622E 02	-0.6000000E 00
0.7046703E 01	0.2469347E 01	0.1320939E 02	-0.7000000E 00
0.8232158E 01	0.2661377E 01	0.1370328E 02	-0.8000000E 00
0.9974273E 01	0.2922477E 01	0.1436721E 02	-0.9000000E 00
0.1266837E 02	0.3295650E 01	0.1528563E 02	-0.1000000E 01
0.1715977E 02	0.3814317E 01	0.1661532E 02	-0.1100000E 01
0.2554404E 02	0.4640765E 01	0.1869270E 02	-0.1200000E 01
0.4432752E 02	0.6072204E 01	0.2227696E 02	-0.1300000E 01
0.1034398E 03	0.9246420E 01	0.3016219E 02	-0.1400000E 01
0.1995229E 03	0.1283380E 02	0.3892832E 02	-0.1450000E 01
0.5610940E 03	0.2145068E 02	0.6026403E 02	-0.1500000E 01
0.6289811E 04	0.7153589E 02	0.1839850E 03	-0.1550000E 01
TENSILE END LOADS			
0.4215566E 01	0.1933412E 01	0.1182527E 02	0.3000000E 00
0.3990369E 01	0.1884756E 01	0.1162944E 02	0.4000000E 00
0.3723982E 01	0.1825856E 01	0.1154534E 02	[illegible]
0.3430211E 01	0.1758921E 01	0.1136679E 02	0.6000000E 00
0.3121702E 01	0.1686186E 01	0.1117377E 02	0.7000000E 00
0.2809148E 01	0.1609763E 01	0.1097675E 02	0.8000000E 00
0.2501140E 01	0.1531531E 01	0.1075268E 02	0.9000000E 00
0.2203931E 01	0.1453087E 01	0.1054691E 02	0.1000000E 01
0.1921505E 01	0.1375719E 01	0.1033138E 02	0.1100000E 01
0.1656356E 01	0.1300616E 01	0.1012740E 02	0.1200000E 01
0.1409660E 01	0.1227898E 01	0.9924852E 01	0.1300000E 01
0.1179944E 01	0.1158653E 01	0.9729040E 01	0.1400000E 01
0.9665519E 00	0.1092977E 01	0.9540802E 01	0.1500000E 01
0.7689913E 00	0.1031015E 01	0.9360601E 01	0.1600000E 01
0.5851449E 00	0.9727965E 00	0.9190619E 01	0.1700000E 01
0.4133085E-00	0.9182653E 00	0.9026820E 01	0.1800000E 01
0.2518106E-00	0.8673054E 00	0.8869027E 01	0.1900000E 01
0.9905895E-01	0.8197637E 00	0.8720956E 01	0.2000000E 01
-0.4641108E-01	0.7754509E 00	0.8582618E 01	0.2100000E 01
-0.1859348E-00	0.7341816E 00	0.8446561E 01	0.2200000E 01
-0.3206909E 00	0.6957547E 00	0.8312457E 01	0.2300000E 01
[illegible]	0.6599737E 00	0.8194556E 01	0.2400000E 01
-0.5799612E 00	0.6266450E 00	0.8083468E 01	0.2500000E 01
-0.7061949E 00	0.5955098E 00	0.7973913E 01	0.2600000E 01
-0.8311264E 00	0.5666372E 00	0.7869251E 01	0.2700000E 01
-0.9553344E 00	0.5396114E 00	0.7763447E 01	0.2800000E 01
-0.1079358E 01	0.5143765E 00	0.7676094E 01	0.2900000E 01
-0.1203637E 01	0.4907881E 00	0.7582337E 01	0.3000000E 01

$\overline{T}_D$ = 0.4000000E 01 $\overline{Q}$ = 0.1500000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1013333E 02	0.3000000E 01	0.1500000E 02	0.
0.1113078E 02	0.3138255E 01	0.1527761E 02	-0.3000000E 00
0.1181458E 02	[illegible]	0.1551124E 02	-0.4000000E 00
0.1278263E 02	0.3326495E 01	0.1583112E 02	-0.5000000E 00
0.1415189E 02	0.3521607E 01	0.1625692E 02	-0.6000000E 00
0.1605950E 02	0.3712652E 01	0.1681920E 02	-0.7000000E 00
0.1877957E 02	0.4025223E 01	0.1756442E 02	-0.8000000E 00
0.2278825E 02	0.4426402E 01	0.1858277E 02	-0.9000000E 00
0.2900362E 02	0.4957455E 01	0.1992176E 02	-0.1000000E 01
0.3939819E 02	[illegible]	0.2127574E 02	-0.1100000E 01
0.5883515E 02	0.7022252E 01	0.2511128E 02	-0.1200000E 01
0.1032448E 03	[illegible]	[illegible]	-0.1300000E 01
0.2398094E 03	[illegible]	[illegible]	-0.1400000E 01
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.3245126E 02	[illegible]	-0.1500000E 01
0.1466225E 05	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
0.9616386E 01	0.2828457E 01	[illegible]	0.3000000E 00
0.9107111E 01	[illegible]	[illegible]	[illegible]
0.8511272E 01	[illegible]	[illegible]	[illegible]
0.7856458E 01	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.1621734E 01	0.1145110E 02	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.2600000E 01
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.2900000E 01
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-2 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = 0.8000000E 01 $\overline{Q}$ = 0.

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.2133333E 02	-0.4000000E 01	0.	0.
0.2297255E 02	-0.4155698E 01	-0.3740128E-00	-0.3000000E-00
0.2430088E 02	-0.4285222E 01	-0.6856354E 00	-0.4000000E-00
0.2638937E 02	-0.4463896E 01	-0.1115951E 01	-0.5000000E 00
0.2919913E 02	-0.4702851E 01	-0.1673026E 01	-0.6000000E 00
0.3313836E 02	-0.5019743E 01	-0.2459674E 01	-0.7000000E 00
0.3876204E 02	-0.5441553E 01	-0.3492594E 01	-0.8000000E 00
0.4706134E 02	-0.6012107E 01	-0.4959806E 01	-0.9000000E 00
0.5994622E 02	-0.6806526E 01	-0.6806526E 01	-0.1000000E 01
0.8150111E 02	-0.7964326E 01	-0.9636435E 01	-0.1100000E 01
0.1218512E 03	-0.9776111E 01	-0.1407763E 02	-0.1200000E 01
0.2124340E 03	-0.1296753E 02	-0.2190667E 02	-0.1300000E 01
0.4978611E 03	-0.1993241E 02	-0.3906792E 02	-0.1400000E 01
0.9620203E 03	-0.2777092E 02	-0.5938451E 02	-0.1450000E 01
0.2708984E 04	-0.4670874E 02	-0.1050347E 03	-0.1500000E 01
0.3038903E 05	-0.1567996E 03	-0.3767110E 03	-0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1786236E 02	-0.3855297E 01	0.3467767E-00	0.3000000E-00
0.1582005E 02	-0.3749627E 01	0.5979404E 00	0.4000000E 00
0.1759501E 02	-0.3621966E 01	0.7054499E 00	0.5000000E 00
0.1625154E 02	-0.3476651E 01	0.1251524E 01	0.6000000E 00
0.1485012E 02	-0.3319094E 01	0.1625356E 01	0.7000000E 00
0.1344287E 02	-0.3153751E 01	0.2018497E 01	0.8000000E 00
0.1207112E 02	-0.2984764E 01	0.2417543E 01	0.9000000E 00
0.1076517E 02	-0.2815568E 01	0.2813556E 01	0.1000000E 01
0.9544451E 01	-0.2649043E 01	0.3205327E 01	0.1100000E 01
0.8417826E 01	-0.2487292E 01	0.3541711E 01	0.1200000E 01
0.7395129E 01	-0.2331933E 01	0.3940970E 01	0.1300000E 01
0.6467214E 01	-0.2183392E 01	0.4230624E 01	0.1400000E 01
0.5637096E 01	-0.2041036E 01	0.4592232E 01	0.1500000E 01
0.4892280E 01	-0.1912558E 01	0.4936174E 01	0.1600000E 01
0.4226771E 01	-0.1787463E 01	0.5171464E 01	0.1700000E 01
0.3632296E 01	0.1674556E 01	0.5425561E 01	0.1800000E 01
0.3100697E 01	-0.1567664E 01	0.5659266E 01	0.1900000E 01
0.2626237E 01	0.1469383E 01	0.5873582E 01	0.2000000E 01
0.2195771E 01	-0.1376336E 01	0.6067644E 01	0.2100000E 01
0.1808033E 01	-0.1291044E 01	0.6248651E 01	0.2200000E 01
0.1457647E 01	0.1212065E 01	0.6411822E 01	0.2300000E 01
0.1137115E 01	0.1138951E 01	0.6560360E 01	0.2400000E 01
0.8427672E 00	-0.1071262E 01	0.6695430E 01	0.2500000E 01
0.5707070E 00	-0.1008612E 01	0.6818142E 01	0.2600000E 01
0.3175567E 00	0.9505551E 00	0.6929547E 01	0.2700000E 01
0.8031886E-01	0.8967632E 00	0.7030321E 01	0.2800000E 01
0.1433220E-00	0.8468930E 00	0.7122286E 01	0.2900000E 01
0.3557551E 00	0.8005974E 00	0.7205176E 01	0.3000000E 01

$\overline{T}_D$ = 0.8000000E 01 $\overline{Q}$ = 0.3000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1253333E 02	-0.3000000E 01	0.3000000E 01	0.
0.1349090E 02	-0.3118337E 01	0.2773350E 01	-0.3000000E-00
0.1431297E 02	-0.3216790E 01	0.2485314E 01	-0.4000000E-00
0.1540457E 02	-0.3352546E 01	0.2161863E 01	-0.5000000E 00
0.1712223E 02	-0.3534285E 01	0.1727657E 01	-0.6000000E 00
0.1941618E 02	-0.3775238E 01	0.1150133E 01	-0.7000000E 00
0.2268806E 02	-0.4096014E 01	0.3785509E-00	-0.8000000E 00
0.2751231E 02	-0.4529974E 01	-0.6692772E 00	-0.9000000E 00
0.3499583E 02	-0.5134303E 01	-0.2134303E 01	-0.1000000E 01
0.4750565E 02	-0.6015206E 01	-0.4278399E 01	-0.1100000E 01
0.7090969E 02	-0.7393923E 01	-0.7667249E 01	-0.1200000E 01
0.1234269E 03	-0.9819011E 01	-0.1359413E 02	-0.1300000E 01
0.2888650E 03	-0.1512443E 02	-0.2664388E 02	-0.1400000E 01
0.5578699E 03	-0.2109117E 02	-0.4134418E 02	-0.1450000E 01
0.1570298E 04	-0.3550748E 02	-0.7689182E 02	-0.1500000E 01
0.1761168E 05	-0.1193157E 03	-0.2836559E 03	0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1167326E 02	-0.2990032E 01	0.3260103E 01	0.3000000E-00
0.1106337E 02	-0.2809735E 01	0.3447557E 01	0.4000000E-00
0.1034587E 02	-0.2712607E 01	0.3678152E 01	0.5000000E 00
0.9558086E 01	-0.2602340E 01	0.3936842E 01	0.6000000E 00
0.8735073E 01	-0.2482661E 01	0.4216504E 01	0.7000000E 00
0.7907055E 01	-0.2357091E 01	0.4508535E 01	0.8000000E 00
0.7098022E 01	-0.2228768E 01	0.4805302E 01	0.9000000E 00
0.6325440E 01	-0.2100348E 01	0.5100348E 01	0.1000000E 01
0.5600708E 01	-0.1973972E 01	0.5388507E 01	0.1100000E 01
0.4930023E 01	-0.1851293E 01	0.5665847E 01	0.1200000E 01
0.4315836E 01	-0.1733469E 01	0.5929562E 01	0.1300000E 01
0.3757232E 01	-0.1621130E 01	0.6177905E 01	0.1400000E 01
0.3251586E 01	-0.1515346E 01	0.6409528E 01	0.1500000E 01
0.2794975E 01	-0.1415743E 01	0.6624301E 01	0.1600000E 01
0.2382041E 01	-0.1322555E 01	0.6822183E 01	0.1700000E 01
0.2010408E 01	-0.1235670E 01	0.7003571E 01	0.1800000E 01
0.1672963E 01	-0.1154979E 01	0.7167115E 01	0.1900000E 01
0.1366037E 01	-0.1079906E 01	0.7319624E 01	0.2000000E 01
0.1085505E 01	-0.1010432E 01	0.7456924E 01	0.2100000E 01
0.8276309E 00	-0.9461178E 00	0.7572219E 01	0.2200000E 01
0.5896821E 00	-0.8886180E 00	0.7690209E 01	0.2300000E 01
0.3669145E-00	-0.8315893E 00	0.7789954E 01	0.2400000E 01
0.1585476E 00	-0.7806948E 00	0.7879167E 01	0.2500000E 01
-0.3626600E-01	-0.7336244E 00	0.7959328E 01	0.2600000E 01
-0.2256772E-00	-0.6900776E 00	0.8030666E 01	0.2700000E 01
-0.4047718E 00	-0.6497650E 00	0.8094157E 01	0.2800000E 01
-0.5776133E 00	-0.6124285E 00	0.8150523E 01	0.2900000E 01
-0.7452534E 00	-0.5778257E 00	0.8200431E 01	0.3000000E 01

$\overline{T}_D$ = 0.8000000E 01 $\overline{Q}$ = 0.6000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.6133333E 01	0.2000000E 01	0.6000000E 01	0.
0.6509185E 01	0.2083378E 01	0.5812712E 01	0.3000000E 00
0.6985985E 01	0.2148355E 01	0.5558263E 01	0.4000000E 00
0.7550702E 01	0.2261285E 01	0.5417578E 01	0.5000000E 00
0.8335162E 01	0.2365718E 01	[illegible]	[illegible]
0.9429015E 01	-0.2530736E 01	0.4752280E 01	0.7000000E 00
0.1028869E 02	0.2253675E 01	[illegible]	[illegible]
0.1327836E 02	0.3067862E 01	0.3511265E 01	0.9000000E 00
0.1682535E 02	0.3452079E 01	0.2537922E 01	0.1000000E 01
0.2274221E 02	0.4062796E 01	[illegible]	[illegible]
0.3372650E 02	0.5211116E 01	[illegible]	[illegible]
0.5858577E 02	0.6679498E 01	[illegible]	[illegible]
0.1365612E 03	0.1051675E 02	[illegible]	[illegible]
0.2632789E 03	-0.1481135E 02	[illegible]	[illegible]
0.7523102E 03	-0.2635821E 02	0.4658429E 02	[illegible]
0.8298185E 04	0.8185177E 02	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.5718363E 01	[illegible]	[illegible]	[illegible]
0.5425643E 01	0.1809845E 01	[illegible]	[illegible]
0.5075305E 01	0.1825412E 01	[illegible]	[illegible]
0.4691098E 01	[illegible]	[illegible]	[illegible]
0.4291551E 01	0.1686279E 01	[illegible]	[illegible]
0.3965530E 01	0.1550612E 01	[illegible]	[illegible]
0.3462416E 01	[illegible]	[illegible]	[illegible]
[illegible]	0.1385111E 01	[illegible]	[illegible]
0.2719995E 01	0.1298214E 01	[illegible]	[illegible]
0.2372058E 01	0.1215267E 01	[illegible]	[illegible]
[illegible]	0.1135202E 01	[illegible]	[illegible]
[illegible]	0.1058661E 01	[illegible]	[illegible]
[illegible]	0.9865800E 00	[illegible]	[illegible]
[illegible]	0.9182198E 00	[illegible]	[illegible]
[illegible]	0.8555764E 00	[illegible]	[illegible]
[illegible]	0.7967841E 00	[illegible]	[illegible]
[illegible]	0.7421951E 00	[illegible]	[illegible]
[illegible]	0.6914565E 00	[illegible]	[illegible]
[illegible]	0.6445792E 00	[illegible]	[illegible]
[illegible]	0.6031712E 00	[illegible]	[illegible]
[illegible]	0.5631172E 00	[illegible]	[illegible]
0.1055159E 02	0.5262212E 00	[illegible]	[illegible]
0.3115264E 00	[illegible]	[illegible]	[illegible]
0.4718006E 00	0.4595554E 00	[illegible]	[illegible]
0.6132527E 00	-0.4298202E 00	[illegible]	[illegible]
0.7506859E 00	0.4021667E 00	[illegible]	[illegible]
0.8867103E 00	0.3772740E 00	[illegible]	[illegible]
0.1021995E 01	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = 0.8000000E 01 $\overline{Q}$ = 0.9000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.2133333E 01	[illegible]	0.9000000E 01	0.
0.2202635E 01	0.1043615E 01	0.8996376E 01	0.3000000E 00
0.2403912E 01	[illegible]	0.8521212E 01	0.4000000E 00
[illegible]	[illegible]	[illegible]	0.5000000E 00
[illegible]	[illegible]	0.8562025E 01	0.6000000E 00
[illegible]	[illegible]	[illegible]	0.7000000E 00
[illegible]	[illegible]	0.8102440E 01	0.8000000E 00
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.1000000E 01
[illegible]	[illegible]	[illegible]	0.1100000E 01
[illegible]	[illegible]	0.5211352E 01	0.1200000E 01
[illegible]	[illegible]	[illegible]	0.1300000E 01
[illegible]	0.5506267E 01	[illegible]	0.1400000E 01
[illegible]	[illegible]	[illegible]	0.1450000E 01
[illegible]	[illegible]	0.2081616E 02	0.1500000E 01
[illegible]	[illegible]	[illegible]	0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	0.7036355E 01	0.3000000E 00
[illegible]	[illegible]	0.7168792E 01	0.4000000E 00
[illegible]	-0.4982305E 00	0.9223558E 01	0.5000000E 00
0.1656652E 01	0.3531715E 01	0.9107330E 01	0.6000000E 00
[illegible]	[illegible]	0.9196729E 01	0.7000000E 00
[illegible]	[illegible]	0.9650614E 01	0.8000000E 00
[illegible]	[illegible]	[illegible]	0.9000000E 00
[illegible]	0.6699132E 00	0.9669213E 01	0.1000000E 01
[illegible]	[illegible]	[illegible]	0.1100000E 01
[illegible]	[illegible]	0.9836122E 01	0.1200000E 01
[illegible]	0.5165359E 00	[illegible]	0.1300000E 01
[illegible]	[illegible]	[illegible]	0.1400000E 01
[illegible]	[illegible]	[illegible]	0.1500000E 01
[illegible]	[illegible]	0.1009435E 02	0.1500000E 01
[illegible]	[illegible]	0.1012163E 02	0.1700000E 01
[illegible]	[illegible]	[illegible]	0.1800000E 01
[illegible]	[illegible]	[illegible]	0.1900000E 01
[illegible]	[illegible]	0.1021121E 02	0.2000000E 01
[illegible]	[illegible]	[illegible]	0.2100000E 01
[illegible]	[illegible]	[illegible]	0.2200000E 01
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.2400000E 01
[illegible]	[illegible]	[illegible]	0.2500000E 01
[illegible]	[illegible]	[illegible]	0.2600000E 01
[illegible]	[illegible]	[illegible]	0.2700000E 01
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.1019035E 02	[illegible]

TABLE 1.5-2 (Cont'd)

VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = 0.8000000E 01 $\overline{Q}$ = 0.1200000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.5333335E 00	0.	0.1200000E 02	0.
0.5555510E 00	-0.6254494E-02	0.1199944E 02	-0.3000000E-00
0.5727811E 00	-0.1149386E-01	0.1199916E 02	-0.4000000E-00
0.5957810E 00	-0.1876736E-01	0.1199531E 02	-0.5000000E 00
0.6245249E 00	-0.2858496E-01	0.1198971E 02	-0.6000000E 00
0.6598322E 00	-0.4172421E-01	0.1197725E 02	-0.7000000E 00
0.7029355E 00	-0.5939919E-01	0.1195129E 02	-0.8000000E 00
0.7558571E 00	-0.8357456E-01	0.1191530E 02	-0.9000000E 00
0.8225568E 00	-0.1176332E 00	0.1183237E 02	-0.1000000E 01
0.9114110E 00	-0.1678454E 00	0.1172621E 02	-0.1100000E 01
0.1043086E 01	-0.2473009E 00	0.1164349E 02	-0.1200000E 01
0.1281556E 01	0.3894597E-00	0.1134355E 02	-0.1300000E 01
0.1720714E 01	-0.6998854E 00	0.1062942E 02	-0.1400000E 01
0.2895134E 01	-0.1051697E 01	0.7768902E 01	-0.1450000E 01
0.4576849E 01	0.1901691E 01	0.7716676E 01	-0.1500000E 01
0.6273829E 02	-0.6863909E 01	-0.4490543E 01	-0.1550000E 01
TENSILE END LOADS			
0.5111790E 00	0.5763162E-02	[illegible]	0.3000000E-00
0.4950744E-00	0.9942742E 02	0.1199841E 02	0.4000000E 00
0.4739621E-00	0.1495790E 01	0.1197626E 02	0.5000000E 00
0.4486954E-00	0.2059513E 01	0.1199159E 02	0.6000000E 00
0.4189514E-00	0.2663924E 01	0.1198625E 02	0.7000000E 00
0.3653687E-00	0.3288747E-01	0.1197395E 02	0.8000000E 00
0.3478874E 00	0.3715915E 01	0.1196820E 02	0.9000000E 00
0.3066250E-00	0.4530453E 01	0.1195469E 02	0.1000000E 01
0.2616582E-00	0.5120332E-01	0.1193804E 02	0.1100000E 01
0.2130634E-00	0.5676604E-01	0.1191026E 02	0.1200000E 01
0.1609108E-00	0.6193042E-01	0.1189534E 02	0.1300000E 01
0.1052395E 00	[illegible]	0.1186235E 02	0.1400000E 01
0.4609521E-01	[illegible]	0.1184042E 02	0.1500000E 01
0.1646562E-01	0.7573100E 01	0.1180469E 02	0.1600000E 01
0.8246619E 01	0.7808000E 01	0.1177435E 02	0.1700000E 01
-0.1510131E-00	0.8098736E 01	0.1173760E 02	0.1800000E 01
0.7245066E-00	0.8347355E 01	0.1159966E 02	0.1900000E 01
0.3005058E-00	0.8554308E 01	0.1165775E 02	0.2000000E 01
0.3797848E-00	0.8728262E 01	0.1161530E 02	0.2100000E 01
0.4623222E-00	0.8865982E 01	0.1157089E 02	0.2200000E 01
0.5480897E 00	0.8972232E 01	0.1152517E 02	0.2300000E 01
-0.6370637E 00	0.9049742E 01	0.1147873E 02	0.2400000E 01
0.7292248E 00	0.9101140E 01	0.1143118E 02	0.2500000E 01
0.8245512E 00	0.2128929E 01	0.1138288E 02	0.2600000E 01
0.9230209E 00	0.9135470E 01	0.1133402E 02	0.2700000E 01
0.1024638E 01	0.9112771E 01	0.1128476E 02	0.2800000E 01
0.1129369E 01	0.9093498E 01	0.1123552E 02	0.2900000E 01
0.1237257E 01	0.9064938E 01	0.1119456E 02	0.3000000E 01

$\overline{T}_D$ = 0.8000000E 01 $\overline{Q}$ = 0.1500000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1333334E 01	0.1000000E 01	0.1500000E 02	0.
0.1413631E 01	0.1031106E 01	0.1509290E 02	-0.3000000E 00
0.1480568E 01	0.1056938E 01	0.1516711E 02	-0.4000000E-00
0.1574726E 01	0.1092472E 01	0.1527312E 02	-0.5000000E 00
0.1702953E 01	0.1139982E 01	0.1541039E 02	-0.6000000E 00
0.1877780E 01	0.1202781E 01	0.1558736E 02	-0.7000000E 00
0.2120160E 01	0.1286113E 01	0.1582315E 02	-0.8000000E 00
0.2467255E 01	0.1398556E 01	0.1613283E 02	-0.9000000E 00
0.2990793E 01	0.1554593E 01	0.1655459E 02	-0.1000000E 01
0.3846468E 01	0.1781274E 01	0.1715534E 02	-0.1100000E 01
0.5468868E 01	0.2149071E 01	0.1807627E 02	-0.1200000E 01
0.8458444E 01	0.2755058E 01	0.1965655E 02	-0.1300000E 01
0.1762266E 02	0.4108726E 01	0.2362224E 02	0.1400000E 01
0.3706237E 02	0.4628124E 01	0.2683313E 02	-0.1450000E 01
0.1226151E 03	0.9227572E 01	0.3591253E 02	0.1500000E 01
0.1140782E 04	0.3042001E 02	0.8856457E 02	-0.1550000E 01
TENSILE END LOADS			
0.1259894E 01	0.9710291E 00	0.1491261E 02	0.3000000E 00
0.1206233E 01	0.9498352E 00	0.1484903E 02	0.4000000E 00
0.1141827E 01	0.9241463E 00	0.1476892E 02	0.5000000E 00
0.1068893E 01	0.8949067E 00	0.1467783E 02	0.6000000E 00
0.9899133E 00	0.8630726E 00	0.1457769E 02	0.7000000E 00
0.9067309E 00	0.8295470E 00	0.1446909E 02	0.8000000E 00
0.8209845E 00	0.7951150E 00	0.1435524E 02	0.9000000E 00
0.7338044E 00	0.7605219E 00	0.1423948E 02	0.1000000E 01
0.6462347E 00	0.7262412E 00	0.1412122E 02	0.1100000E 01
0.5581113E 00	0.6927824E 00	0.1400239E 02	0.1200000E 01
0.4702541E-00	0.6603967E 00	0.1388193E 02	0.1300000E 01
0.3924521E 00	0.6293121E 00	0.1376653E 02	0.1400000E 01
0.2946124E 00	0.5996825E 00	0.1365071E 02	0.1500000E 01
0.2065127E 00	0.5717554E 00	0.1353692E 02	0.1600000E 01
0.1179270E 00	0.5449592E 00	0.1342537E 02	0.1700000E 01
0.2955608E 01	0.5190732E 00	0.1331561E 02	0.1800000E 01
0.6175265E 01	0.4962578E 00	0.1320451E 02	0.1900000E 01
0.1553368E 00	0.4743527E 00	0.1310379E 02	0.2000000E 01
-0.2465377E 00	0.4551117E 00	0.1300144E 02	0.2100000E 01
0.3416849E 0[illegible]	0.4311945E 00	0.1290144E 02	0.2200000E 01
0.4176391E 00	0.4153821E 00	0.1280375E 02	0.2300000E 01
0.5161807E 00	0.3974596E 00	0.1272093E 02	0.2400000E 01
0.6168542E 00	0.3815014E 00	0.1261512E 02	0.2500000E 01
0.7127676E 00	0.3662614E 00	0.1252607E 02	0.2600000E 01
0.8450290E 00	0.3518371E 00	0.1243514E 02	0.2700000E 01
0.9527112E 00	0.3382243E 00	0.1234873E 02	0.2800000E 01
0.1062915E 01	0.3253805E 00	0.1226347E 02	0.2900000E 01
0.1175678E 01	0.3132611E 00	0.1218365E 02	0.3000000E 01

$\overline{T}_D$ = 0.1200000E 02 $\overline{Q}$ = 0.

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.4000000E 02	0.6000000E 01	0.	0.
0.5168994E 02	[illegible]	0.5610192E 02	[illegible]
0.5582365E 02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = 0.1200000E 02 $\overline{Q}$ = 0.3000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.3420000E 02	[illegible]	[illegible]	[illegible]
0.3600078E 02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-2 (Cont'd)
VALUES OF $\bar{\lambda}$, $\bar{y}$ AND $\bar{M}$ FOR SPECIFIED VALUES OF $\bar{T}_d$, $\bar{T}$ AND $\bar{Q}$

$\bar{T}_D$ = 0.1200000E 02 $\bar{Q}$ = 0.6000000E 01

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.2280000E 02	-0.4000000E 01	0.6000000E 01	0.
0.2451701E 02	-0.4158825E 01	0.5625706E 01	-0.3000000E-00
0.2599787E 02	-0.4290968E 01	0.5313445E 01	-0.4000000E-00
0.2809506E 02	-0.4473189E 01	0.4881703E 01	-0.5000000E 00
0.3103676E 02	-0.4717144E 01	0.4301828E 01	-0.6000000E 00
0.3516020E 02	-0.5040605E 01	0.3530103E 01	-0.7000000E 00
0.4104572E 02	-0.5473252E 01	0.2490390E 01	-0.8000000E 00
0.4972972E 02	-0.6053825E 01	0.1076345E 01	-0.9000000E 00
0.6320927E 02	-0.6865342E 01	-0.8653424E 00	-0.1000000E 01
0.8575505E 02	-0.8048749E 01	-0.3738392E 01	-0.1100000E 01
0.1279538E 03	-0.9899781E 01	-0.8255685E 01	-0.1200000E 01
0.2226761E 03	-0.1315676E 02	-0.1623492E 02	-0.1300000E 01
0.5211268E 03	-0.2028255E 02	-0.3375381E 02	-0.1400000E 01
0.1006446E 04	-0.2879684E 02	-0.5349411E 02	-0.1450000E 01
0.2833041E 04	-0.4766059E 02	-0.1012363E 03	-0.1500000E 01
0.3177470E 05	-0.1602315E 03	-0.3789563E 03	-0.1550000E 01
TENSILE END LOADS			
0.2125886E 02	-0.3852415E 01	0.6346717E 01	0.3000000E-00
0.2016607E 02	-0.3744650E 01	0.6599145E 01	0.4000000E-00
0.1888307E 02	-0.3614311E 01	0.6903579E 01	0.5000000E 00
0.1747483E 02	-0.3466354E 01	0.7247887E 01	0.6000000E 00
0.1600547E 02	-0.3305775E 01	0.7619829E 01	0.7000000E 00
0.1452949E 02	-0.3137301E 01	0.8007877E 01	0.8000000E 00
0.1309020E 02	-0.2965165E 01	0.8401783E 01	0.9000000E 00
0.1171914E 02	0.2792214E 01	0.8792914E 01	0.1000000E 01
0.1043688E 02	-0.2623429E 01	0.9174349E 01	0.1100000E 01
0.9254755E 01	-0.2458916E 01	0.9540839E 01	0.1200000E 01
0.8176823E 01	-0.2300970E 01	0.9888639E 01	0.1300000E 01
0.7201832E 01	-0.2150663E 01	0.1021530E 02	0.1400000E 01
0.6324938E 01	-0.2008640E 01	0.1051944E 02	0.1500000E 01
0.5539086E 01	-0.1875203E 01	0.1080052E 02	0.1600000E 01
0.4836069E 01	-0.1750393E 01	0.1105864E 02	0.1700000E 01
0.4207289E 01	-0.1634062E 01	0.1122436E 02	0.1800000E 01
0.3644261E 01	-0.1525927E 01	0.1150960E 02	0.1900000E 01
0.3138938E 01	-0.1425614E 01	0.1170246E 02	0.2000000E 01
0.2683894E 01	-0.1332695E 01	0.1187719E 02	0.2100000E 01
0.2272406E 01	-0.1246714E 01	0.1203409E 02	0.2200000E 01
0.1898471E 01	-0.1167204E 01	0.1217451E 02	0.2300000E 01
0.1556722E 01	-0.1093703E 01	0.1229973E 02	0.2400000E 01
0.1242724E 01	-0.1025733E 01	0.1241102E 02	0.2500000E 01
0.9522242E 00	-0.9629563E 00	0.1250758E 02	0.2600000E 01
0.6817800E 00	-0.9068777E 00	0.1259636E 02	0.2700000E 01
0.4203556E-00	-0.8511483E 00	0.1267300E 02	0.2800000E 01
0.1893280E-00	-0.8014155E 00	0.1273990E 02	0.2900000E 01
-0.3753540E-01	-0.7553527E 00	0.1279817E 02	0.3000000E 01

$\bar{T}_D$ = 0.1200000E 02 $\bar{Q}$ = 0.9000000E 01

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.1380000E 02	-0.3000000E 01	0.9000000E 01	0.
0.1481817E 02	-0.3121464E 01	0.8739068E 01	-0.3000000E-00
0.1569187E 02	-0.3222536E 01	0.8684326E 01	-0.4000000E-00
0.1693700E 02	-0.3361930E 01	0.8159511E 01	0.5000000E 00
0.1867687E 02	-0.3549557E 01	0.7722512E 01	-0.6000000E 00
0.2111324E 02	-0.3796100E 01	0.7139911E 01	-0.7000000E 00
0.2458716E 02	0.4125714E 01	0.6357545E 01	-0.8000000E 00
0.2970761E 02	-0.4571763E 01	0.5296872E 01	-0.9000000E 00
0.3764807E 02	-0.5193119E 01	0.3856801E 01	-0.1000000E 01
0.5091790E 02	-0.6099129E 01	0.1520054E 01	-0.1100000E 01
0.7573762E 02	-0.7517575E 01	-0.1825306E 01	-0.1200000E 01
0.1314209E 03	-0.1001324E 02	-0.7922577E 01	-0.1300000E 01
0.3068109E 03	-0.1547437E 02	-0.2132977E 02	-0.1400000E 01
0.5919845E 03	-0.2161702E 02	-0.3644978E 02	-0.1450000E 01
0.1665247E 04	-0.3645932E 02	-0.7303148E 02	-0.1500000E 01
0.1867042E 05	-0.1227476E 03	-0.2859012E 03	-0.1550000E 01
TENSILE END LOADS			
0.1288507E 02	-0.2887150E 01	0.9259843E 01	0.3000000E-00
0.1223652E 02	-0.2804763E 01	0.9448762E 01	0.4000000E-00
0.1147305E 02	-0.2705128E 01	0.9676282E 01	0.5000000E 00
0.1063446E 02	-0.2592042E 01	0.9935135E 01	0.6000000E 00
0.9758029E 01	-0.2469341E 01	0.1020498E 02	0.7000000E 00
0.8875775E 01	-0.2340648E 01	0.1049801E 02	0.8000000E 00
0.8013186E 01	-0.2209189E 01	0.1076944E 02	0.9000000E 00
0.7188825E 01	-0.2077696E 01	0.1107372E 02	0.1000000E 01
0.6438822E 01	0.1943371E 01	0.1135753E 02	0.1100000E 01
0.5697872E 01	0.1822900E 01	0.1162499E 02	0.1200000E 01
0.5040412E 01	-0.1702503E 01	0.1187723E 02	0.1300000E 01
0.4441762E 01	0.1588201E 01	0.1211268E 02	0.1400000E 01
0.3899060E 01	-0.1479883E 01	0.1232797E 02	0.1500000E 01
0.3409260E 01	-0.1378378E 01	0.1252865E 02	0.1600000E 01
0.2964565E 01	-0.1283515E 01	0.1270936E 02	0.1700000E 01
0.2562959E 01	-0.1195176E 01	0.1287237E 02	0.1800000E 01
0.2198498E 01	-0.1113143E 01	0.1301844E 02	0.1900000E 01
0.1866427E 01	-0.1037126E 01	0.1314850E 02	0.2000000E 01
0.1562602E 01	-0.9667904E 00	0.1326355E 02	0.2100000E 01
0.1282919E 01	-0.9017879E 00	0.1336466E 02	0.2200000E 01
0.1023943E 01	0.8417568E 00	0.1345280E 02	0.2300000E 01
0.7875809E 00	-0.7863405E 00	0.1352952E 02	0.2400000E 01
0.5561535E 00	-0.7351931E 00	0.1359476E 02	0.2500000E 01
0.3422823E-00	-0.6879036E 00	0.1365077E 02	0.2600000E 01
0.1369315E-00	-0.6444003E 00	0.1369768E 02	0.2700000E 01
-0.5566485E-01	-0.6061501E 00	0.1373655E 02	0.2800000E 01
-0.2630529E-00	-0.5639610E 00	0.1376814E 02	0.2900000E 01
-0.4244805E-00	-0.5725010E 00	0.1379321E 02	0.3000000E 01

$\bar{T}_D$ = 0.1200000E 02 $\bar{Q}$ = 0.1200000E 02

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.7200000E 01	-0.2000000E 01	0.1200000E 02	0.
0.7704260E 01	0.2084104E 01	0.1163254E 02	-0.3000000E-00
0.8135799E 01	0.2158105E 01	0.1165534E 02	-0.4000000E-00
0.8759868E 01	0.2250670E 01	0.1163733E 02	-0.5000000E 00
0.9605806E 01	-0.2380011E 01	0.1134320E 02	-0.6000000E 00
0.1080131E 02	0.2551598E 01	0.1074972E 02	0.7000000E 00
0.1250140E 02	0.2780175E 01	0.1022069E 02	0.8000000E 00
0.1500061E 02	-0.3089610E 01	0.9497359E 01	0.9000000E 00
0.1886652E 02	0.3520894E 01	0.8679104E 01	0.1000000E 01
0.2551227E 02	0.4150209E 01	0.6978489E 01	0.1100000E 01
0.3734775E 02	0.5135785E 01	0.4605073E 01	0.1200000E 01
0.6451174E 02	0.6869772E 01	0.3901608E 00	-0.1300000E 01
0.1491700E 03	0.1066419E 02	0.8905736E 01	-0.1400000E 01
0.2871025E 03	0.1493719E 02	0.1905565E 02	0.1450000E 01
0.8061600E 03	0.2525806E 02	0.4453056E 02	0.1500000E 01
0.2029983E 04	0.3576372E 02	0.1279460E 03	-0.1550000E 01
TENSILE END LOADS			
0.6785574E 01	0.1921845E 01	0.1217237E 02	0.3000000E-00
0.6441119E 01	-0.1864871E 01	0.1229434E 02	0.4000000E-00
0.6042202E 01	0.1795904E 01	0.1244320E 02	0.5000000E 00
0.5622550E 01	0.1717730E 01	0.1261838E 02	0.6000000E 00
0.5182092E 01	0.1632208E 01	0.1280012E 02	0.7000000E 00
0.4736359E 01	0.1543983E 01	0.1298415E 02	0.8000000E 00
0.4292729E 01	0.1455213E 01	0.1317710E 02	0.9000000E 00
0.3875136E 01	0.1367473E 01	0.1336158E 02	0.1000000E 01
0.3476703E 01	0.1282311E 01	0.1355673E 02	0.1100000E 01
0.3098083E 01	0.1186085E 01	0.1372913E 02	0.1200000E 01
0.2751160E 01	0.1104837E 01	0.1386382E 02	0.1300000E 01
0.2420926E 01	0.1025112E 01	0.1400968E 02	0.1400000E 01
0.2111688E 01	0.9511761E 00	0.1414903E 02	0.1500000E 01
0.1857511E 01	0.8815531E 00	0.1425678E 02	0.1600000E 01
0.1604142E 01	0.8186365E 00	0.1433608E 02	0.1700000E 01
0.1369203E 01	0.7562986E 00	0.1445018E 02	0.1800000E 01
0.1150358E 01	0.7003503E 00	0.1452829E 02	0.1900000E 01
0.9453812E 00	0.6483647E 00	0.1459559E 02	0.2000000E 01
0.7522273E 00	0.6009596E 00	0.1466993E 02	0.2100000E 01
0.5690198E 00	0.5566262E 00	0.1467521E 02	0.2200000E 01
0.3941688E 00	0.5163101E 00	0.1473128E 02	0.2300000E 01
0.2251570E 00	0.4787931E 00	0.1475497E 02	0.2400000E 01
0.6577211E-01	0.4446270E 00	0.1477849E 02	0.2500000E 01
-0.9622101E-01	0.4130112E 00	0.1479774E 02	0.2600000E 01
0.2486[illegible] 00	0.3839728E 00	0.1474890E 02	0.2700000E 01
0.4004150E 00	0.3571514E 00	0.1480027E 02	0.2800000E 01
0.5502272E 00	0.3325056E 00	0.1479534E 02	0.2900000E 01
0.6706540E 00	0.3098391E 00	0.1476878E 02	0.3000000E 01

$\bar{T}_D$ = 0.1200000E 02 $\bar{Q}$ = 0.1500000E 02

$\bar{T}$	$\bar{y}$	$\bar{M}$	$\bar{\lambda}$
COMPRESSIVE END LOADS			
0.3000000E 01	0.1000000E 01	0.1500000E 02	0.
0.3175284E 01	-0.1064743E 01	0.1470574E 02	-0.4000000E 00
0.3373649E 01	0.1085673E 01	0.1482629E 02	0.6000000E-00
0.3551678E 01	0.1119411E 01	0.1471513E 02	-0.5000000E 00
0.3623578E 01	0.1211565E 01	0.1456786E 02	0.6000000E 00
0.4229409E 01	0.1307021E 01	0.1455252E 02	0.7000000E 00
0.4788434E 01	0.1436847E 01	0.1408154E 02	0.9000000E 00
0.5600715E 01	0.1607423E 01	0.1329703E 02	0.7000000E 00
0.8686465E 01	0.1868471E 01	0.1151338E 02	-0.1000000E 01
0.6539871E 01	0.2209932E 01	0.1233692E 02	0.1100000E 01
0.5278410E 02	0.2755159E 01	0.1165565E 02	-0.1200000E 01
0.2136858E 02	0.3726201E 01	0.1170271E 01	0.1300000E 01
0.4827441E 02	0.5850970E 01	0.3518304E 01	0.1400000E 01
0.2117946E 02	0.8457372E 01	0.2361125E 01	0.1450000E 01
0.2557781E 03	-0.1465440E 02	0.1662790E 03	-0.1500000E 01
0.2855110E 04	0.5777970E 02	0.9910238E 02	0.1550000E 01
TENSILE END LOADS			
0.2850081E 01	-0.9568292E 00	0.1508600E 02	0.3000000E 00
0.2726714E 01	-0.9249784E 00	0.1514400E 02	0.4000000E 00
0.2590764E 01	-0.8867515E 00	0.1522159E 02	0.5000000E 00
0.2439361E 01	-0.8434159E 00	0.1530363E 02	0.6000000E 00
0.2277658E 01	-0.7964760E 00	0.1539027E 02	0.7000000E 00
0.2114368E 01	0.7473284E 00	0.1548024E 02	0.8000000E 00
0.1954852E 01	0.6972372E 00	0.1556476E 02	0.9000000E 00
0.1775314E 01	0.6472611E 00	0.1564726E 02	0.1000000E 01
0.1616797E 01	0.5982536E 00	0.1572389E 02	0.1100000E 01
0.1460190E 01	0.5508672E 00	0.1579325E 02	0.1200000E 01
0.1309067E 01	0.5055707E 00	0.1585643E 02	0.1300000E 01
0.1161396E 01	0.4626767E 00	0.1590695E 02	0.1400000E 01
0.1021022E 01	0.4225690E 00	0.1595033E 02	0.1500000E 01
0.8868178E 00	-0.3847263E 00	0.1598490E 02	0.1600000E 01
0.7581931E 00	0.3472532E 00	0.1601080E 02	0.1700000E 01
0.6760201E 00	-0.3176454E 00	0.1602939E 02	0.1800000E 01
0.6905396E-00	-0.2875761E 00	0.1603616E 02	0.1900000E 01
0.5736169E 00	-0.2601450E 00	0.1604358E 02	0.2000000E 01
0.2527735E 00	-0.2349820E 00	0.1603624E 02	0.2100000E 01
0.1367737E 00	-0.2119362E 00	0.1602577E 02	0.2200000E 01
0.9148174E 01	0.1903845E 00	0.1600767E 02	0.2300000E 01
0.1125029E 00	-0.1716161E 00	0.1598851E 02	0.2400000E 01
0.1345654E 00	-0.1550529E 00	0.1594203E 02	0.2500000E 01
-0.1572833E 00	0.1380186E 00	0.1591314E 02	0.2600000E 01
0.4809710E 00	0.1236456E 00	0.1587892E 02	0.2700000E 01
0.1058944E 00	-0.1101515E 00	0.1586360E 02	0.2800000E 01
0.7321957E 00	-0.4805701E-01	0.1582462E 02	0.2900000E 01
0.6600642E 00	0.4201767E-01	0.1576336E 02	0.3000000E 01

TABLE 1.5-2 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = 0.1600000E 02 $\overline{Q}$ = 0.

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.8533333E 02	-0.8000000E 01	0.	0.
0.9184519E 02	-0.8311396E 01	-0.7480257E 00	-0.3000000E-00
0.9744352E 02	-0.8570443E 01	-0.1371271E 01	-0.4000000E-00
0.1054325E 03	-0.8927611E 01	-0.2231903E 01	-0.5000000E 00
0.1156165E 03	-0.9405702E 01	-0.3186053E 01	-0.6000000E 00
0.1323084E 03	-0.1003949E 02	-0.4919349E 01	-0.7000000E 00
0.1547281E 03	-0.1088310E 02	-0.6965187E 01	-0.8000000E 00
0.1878404E 03	-0.1202421E 02	-0.7739613E 01	-0.9000000E 00
0.2392849E 03	-0.1361305E 02	-0.1361335E 02	-0.1000000E 01
0.3253995E 03	-0.1592865E 02	-0.1927367E 02	-0.1100000E 01
0.4666848E 03	-0.1955276E 02	-0.2815576E 02	-0.1200000E 01
0.8408909E 03	-0.2597506E 02	-0.4381335E 02	-0.1300000E 01
0.1990477E 04	-0.3986522E 02	-0.7813534E 02	-0.1400000E 01
0.3847030E 04	-0.5554178E 02	-0.1167770E 03	-0.1450000E 01
0.1083401E 05	-0.9341748E 02	-0.2101893E 03	-0.1500000E 01
0.1755491E 06	-0.3135992E 03	-0.7534220E 03	-0.1550000E 01
TENSILE END LOADS			
0.7749446E 02	-0.7710593E 01	0.6739534E 00	0.3000000E-00
0.7556821E 02	-0.7499255E 01	0.1199881E 01	0.4000000E-00
0.7030505E 02	-0.7245591E 01	0.1810878E 01	0.5000000E 00
0.6552616E 02	-0.6955302E 01	0.2503139E 01	0.6000000E 00
0.5964547E 02	-0.6638189E 01	0.3252712E 01	0.7000000E 00
0.5409149E 02	-0.6307502E 01	0.4036903E 01	0.8000000E 00
0.4868976E 02	-0.5969949E 01	0.4835286E 01	0.9000000E 00
0.4356067E 02	-0.5631113E 01	0.5631113E 01	0.1000000E 01
0.3878280E 02	-0.5298062E 01	0.6410653E 01	0.1100000E 01
0.3439930E 02	-0.4974598E 01	0.7163471E 01	0.1200000E 01
0.3042552E 02	-0.4663870E 01	0.7881240E 01	0.1300000E 01
0.2685646E 02	-0.4367984E 01	0.8561248E 01	0.1400000E 01
0.2367339E 02	-0.4088236E 01	0.9198463E 01	0.1500000E 01
0.2084912E 02	-0.3825136E 01	0.9792344E 01	0.1600000E 01
0.1835209E 02	-0.3578866E 01	0.1034292E 02	0.1700000E 01
0.1614918E 02	-0.3349112E 01	0.1085112E 02	0.1800000E 01
0.1420779E 02	-0.3135577E 01	0.1131859E 02	0.1900000E 01
0.1249695E 02	-0.2936931E 01	0.1174716E 02	0.2000000E 01
0.1098809E 02	-0.2752473E 01	0.1213929E 02	0.2100000E 01
0.9655330E 01	-0.2582087E 01	0.1249730E 02	0.2200000E 01
0.8475589E 01	-0.2424130E 01	0.1282364E 02	0.2300000E 01
0.7428461E 01	-0.2277903E 01	0.1312072E 02	0.2400000E 01
0.6496006E 01	-0.2142530E 01	0.1339086E 02	0.2500000E 01
0.5662831E 01	-0.2017202E 01	0.1363628E 02	0.2600000E 01
0.4915227E 01	-0.1901110E 01	0.1385509E 02	0.2700000E 01
0.4241555E 01	-0.1793526E 01	0.1406125E 02	0.2800000E 01
0.3631712E 01	-0.1693766E 01	0.1424457E 02	0.2900000E 01
0.3076979E 01	-0.1601195E 01	0.1441075E 02	0.3000000E 01

$\overline{T}_D$ = 0.1600000E 02 $\overline{Q}$ = 0.3000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.6653333E 02	-0.7000000E 01	0.3000000E 01	0.
0.7158943E 02	-0.7274035E 01	0.2345337E 01	-0.3000000E-00
0.7595573E 02	-0.7502011E 01	0.1799678E 01	-0.4000000E-00
0.8213741E 02	-0.7816352E 01	0.1045912E 01	-0.5000000E 00
0.9081829E 02	-0.8237136E 01	0.3463107E-01	-0.6000000E 00
0.1029966E 03	-0.8794981E 01	-0.1309541E 01	-0.7000000E 00
0.1203738E 03	-0.9537527E 01	-0.3104043E 01	-0.8000000E 00
0.1460847E 03	-0.1054208E 02	-0.5539086E 01	-0.9000000E 00
0.1859942E 03	-0.1194083E 02	-0.8940828E 01	-0.1000000E 01
0.2527925E 03	-0.1397953E 02	-0.1391523E 02	-0.1100000E 01
0.3778886E 03	-0.1717005E 02	-0.2172488E 02	-0.1200000E 01
0.6588037E 03	-0.2278154E 02	-0.3550808E 02	-0.1300000E 01
0.1544439E 04	-0.3505704E 02	-0.6571180E 02	-0.1400000E 01
0.2983939E 04	-0.4886216E 02	-0.9973257E 02	-0.1450000E 01
0.8403387E 04	-0.8221672E 02	-0.1819865E 03	-0.1500000E 01
0.9426831E 05	-0.2721153E 03	-0.6603669E 03	-0.1550000E 01
TENSILE END LOADS			
0.6199915E 02	0.6745328E 01	0.3697079E 01	0.3000000E-00
0.5873335E 02	-0.6559362E 01	0.4049428E 01	0.4000000E-00
0.5501714E 02	-0.6334403E 01	0.4583601E 01	0.5000000E 00
0.5088502E 02	-0.6078791E 01	0.5134437E 01	0.6000000E 00
0.4647963E 02	-0.5801755E 01	0.5812860E 01	0.7000000E 00
0.4276270E 02	-0.5510842E 01	0.6526773E 01	0.8000000E 00
0.3806264E 02	-0.5213513E 01	0.7222545E 01	0.9000000E 00
0.3407205E 02	-0.4915914E 01	0.7915914E 01	0.1000000E 01
0.3035410E 02	-0.4623003E 01	0.8593834E 01	0.1100000E 01
0.2694049E 02	-0.4338592E 01	0.9247558E 01	0.1200000E 01
0.2384335E 02	0.4065405E 01	0.9873532E 01	0.1300000E 01
0.2105905E 02	-0.3805321E 01	0.1046594E 02	0.1400000E 01
0.1857311E 02	-0.3559449E 01	0.1102047E 02	0.1500000E 01
[illegible]	-0.3328312E 01	0.1152948E 02	0.1600000E 01
0.1440868E 02	-0.3111988E 01	0.1199364E 02	0.1700000E 01
0.1268012E 02	-0.2910228E 01	0.1242713E 02	0.1800000E 01
0.1115351E 02	-0.2722545E 01	0.1292838E 02	0.1900000E 01
0.9949877E 01	0.2548301E 01	0.1317320E 02	0.2000000E 01
0.8612093E 01	0.2386738E 01	0.1352565E 02	0.2100000E 01
0.7555124E 01	-0.2237151E 01	0.1382786E 02	0.2200000E 01
0.6616031E 01	-0.2078185E 01	0.1410203E 02	0.2300000E 01
0.5779174E 01	-0.1970541E 01	0.1435093E 02	0.2400000E 01
0.5030556E 01	0.1851726E 01	0.1457680E 02	0.2500000E 01
0.4356144E 01	0.1742229E 01	0.1477747E 02	0.2600000E 01
0.3751530E 01	-0.1640633E 01	0.1496821E 02	0.2700000E 01
0.3201595E 01	-0.1546520E 01	0.1512478E 02	0.2800000E 01
0.2705518E 01	-0.1459311E 01	0.1527216E 02	0.2900000E 01
0.2251634E 01	0.1378621E 01	0.1541581E 02	0.3000000E 01

$\overline{T}_D$ = 0.1600000E 02 $\overline{Q}$ = 0.6000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.5013333E 02	0.6000000E 01	0.6000000E 01	0.
0.5393860E 02	0.6236874E 01	[illegible]	0.3000000E-00
0.5737187E 02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = 0.1600000E 02 $\overline{Q}$ = 0.9000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.3013333E 02	-0.5000000E 01	[illegible]	0.
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	0.3000000E-00
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-2 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = 0.1600000E 02 $\overline{Q}$ = 0.1200000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.2453333E 02	-0.4000000E 01	0.1200000E 02	0.
0.2633174E 02	-0.4161953E 01	0.1162547E 02	-0.3000000E-00
0.2787592E 02	-0.4296715E 01	0.1131252E 02	-0.4000000E-00
0.3007781E 02	-0.4482573E 01	0.1087936E 02	-0.5000000E 00
0.3315665E 02	-0.4731436E 01	0.1029658E 02	-0.6000000E 00
0.3747113E 02	-0.5061467E 01	0.9519881E 01	-0.7000000E 00
0.4362754E 02	-0.5500952E 01	0.8479391E 01	-0.8000000E 00
0.5270653E 02	-0.6095683E 01	0.7062496E 01	-0.9000000E 00
0.6680027E 02	-0.6924159E 01	0.5075841E 01	-0.1000000E 01
0.9036386E 02	-0.8132172E 01	0.2160072E 01	-0.1100000E 01
0.1344580E 03	-0.1002385E 02	-0.2433741E 01	-0.1200000E 01
0.2334181E 03	-0.1335099E 02	-0.1056317E 02	-0.1300000E 01
0.5451875E 03	-0.2063250E 02	-0.2843969E 02	-0.1400000E 01
0.1052144E 04	-0.2882767E 02	-0.4859971E 02	-0.14 [illegible]000E 01
0.2960148E 04	-0.4851243E 02	-0.9737797E 02	-0.1500000E 01
0.3319154E 05	-0.1636635E 03	-0.5812016E 03	-0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.2291045E 02	-0.3849533E 01	0.1234646E 02	0.3000000E-00
0.2177455E 02	-0.3739685E 01	0.1259835E 02	0.4000000E-00
0.2042894E 02	-0.3606838E 01	0.1290171E 02	0.5000000E 00
0.1895237E [illegible]	-0.3456056E 01	0.1324418E 02	0.6000000E 00
0.1741112E 02	-0.3292455E 01	0.1361330E 02	0.7000000E 00
0.1586212E 02	-0.3120866E 01	0.1399735E 02	0.8000000E 00
0.1435068E 02	-0.2945525E 01	0.1438592E 02	0.9000000E 00
0.1290976E 02	-0.2770261E 01	0.1477026E 02	0.1000000E 01
0.1156098E 02	-0.2597828E 01	0.1514337E 02	0.1100000E 01
0.1031622E 02	0.2430533E 01	0.1549997E 02	0.1200000E 01
0.9179806E 01	-0.2270004E 01	0.1583631E 02	0.1300000E 01
0.8150504E 01	-0.2117335E 01	0.1614998E 02	0.1400000E 01
0.7223328E 01	-0.1973178E 01	0.1643965E 02	0.1500000E 01
0.6390982E 01	-0.1837637E 01	0.1670486E 02	0.1600000E 01
0.5644968E 01	-0.1711355E 01	0.1694581E 02	0.1700000E 01
0.4976372E 01	-0.1593568E 01	0.1716316E 02	0.1800000E 01
0.4376404E 01	-0.1484190E 01	0.1735793E 02	0.1900000E 01
0.3836720E 01	0.1382532E 01	0.1753133E 02	0.2000000E 01
0.3349625E 01	-0.1289054E 01	0.1768473E 02	0.2100000E 01
0.2908151E 01	-0.1202384E 01	0.1781954E 02	0.2200000E 01
0.2506083E 01	0.1122342E 01	0.1793719E 02	0.2300000E 01
0.2137936E 01	-0.1048454E 01	0.1803909E 02	0.2400000E 01
0.1798903E 01	-0.9802576E 00	0.1812661E 02	0.2500000E 01
0.1484798E 01	-0.9173117E 00	0.182[illegible]E 02	0.2600000E 01
0.1191989E 01	0.8592004E 00	0.1826357E 02	0.2700000E 01
0.9173364E 00	-0.8055335E 00	0.1831538E 02	0.2800000E 01
0.6581269E 00	-0.7559680E 00	0.1835752E 02	0.2900000E 01
0.4120707E-00	-0.7101080E 00	0.1839097E 02	0.3000000E 01

$\overline{T}_D$ = 0.1600000E 02 $\overline{Q}$ = 0.1500000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1533333E 02	-0.3000000E 01	0.1500000E 02	0.
0.1641571E 02	-0.3124592E 01	0.1471879E 02	-0.3000000E-00
0.1734384E 02	-0.3228283E 01	0.1448347E 02	-0.4000000E-00
0.1866643E 02	-0.3371313E 01	0.1415717E 02	-0.5000000E 00
0.2051377E 02	-0.3562870E 01	0.1371737E 02	-0.6000000E 00
0.2309938E 02	-0.3816763E 01	0.1312969E 02	-0.7000000E 00
0.2678439E 02	-0.4155413E 01	0.1234053E 02	-0.8000000E 00
0.3221334E 02	-0.4613551E 01	0.1126302E 02	-0.9000000E 00
0.4062827E 02	-0.5251236E 01	0.9748064E 01	-0.1000000E 01
0.5468507E 02	-0.6183052E 01	0.7518507E 01	-0.1100000E 01
0.8096709E 02	-0.7641224E 01	0.3996638E 01	-0.1200000E 01
0.1399149E 03	-0.1020747E 02	-0.2250626E 01	-0.1300000E 01
0.3255538E 03	-0.1592631E 02	-0.1601566E 02	-0.1400000E 01
0.6273714E 03	-0.2214287E 02	-0.3155538E 02	0.1450000E 01
0.1763247E 04	-0.3741117E 02	-0.6917513E 02	-0.1500000E 01
0.1976032E 05	-0.1261796E 03	-0.2881464E 03	-0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1435996E 02	-0.2884269E 01	0.1525258E 02	0.3000000E 00
0.1367055E 02	-0.2799792E 01	0.1544727E 02	0.4000000E-00
0.1285904E 02	-0.2697649E 01	0.1567441E 02	0.5000000E 00
0.1196508E 02	-0.2581764E 01	0.1592943E 02	0.6000000E 00
0.1103129E 02	0.2456022E 01	0.1620345E 02	0.7000000E 00
0.1009051E 02	-0.2324204E 01	0.1648749E 02	0.8000000E 00
0.9169795E 01	-0.2189609E 01	0.1677558E 02	0.9000000E 00
0.8288856E 01	-0.2055044E 01	0.1705504E 02	0.1000000E 01
0.7460599E 01	[illegible].1922769E 01	0.1732655E 02	0.1100000E 01
0.6692183E 01	-0.1779517E 01	0.1758410E 02	0.1200000E 01
0.5986277E 01	-0.1671538E 01	0.1782420E 02	0.1300000E 01
0.5342204E 01	-0.1554673E 01	0.1804716E 02	0.1400000E 01
0.4757081E 01	-0.1444420E 01	0.1824995E 02	0.1500000E 01
0.4226637E 01	0.1341012E 01	0.1843299E 02	0.1600000E 01
0.3745890E 01	-0.1244425E 01	0.1859653E 02	0.1700000E 01
0.3309602E 01	-0.1154683E 01	0.1874117E 02	0.1800000E 01
0.2912631E 01	-0.1071406E 01	0.1886777E 02	0.1900000E 01
0.2550020E 01	-0.9943128E 00	0.1897737E 02	0.2000000E 01
0.2217306E 01	-0.9231491E 00	0.1907109E 02	0.2100000E 01
0.1910378E 01	-0.8574580E 00	0.1915010E 02	0.2200000E 01
0.1625593E 01	-0.7968257E 00	0.1921558E 02	0.2300000E 01
0.1359712E 01	-0.7410919E 00	0.1926869E 02	0.2400000E 01
0.1109780E 01	-0.6896874E 00	0.1931055E 02	0.2500000E 01
0.8738800E 00	-0.6423372E 00	0.1934227E 02	0.2600000E 01
0.6493255E 00	-0.5987229E 00	0.1936469E 02	0.2700000E 01
0.4344579E 00	-0.5505352E 00	0.1937892E 02	0.2800000E 01
0.2276963E-00	-0.5214935E 00	0.1938576E 02	0.2900000E 01
0.2767329E-01	-0.4873163E 00	0.1938603E 02	0.3000000E 01

$\overline{T}_D$ = 0.2000000E 02 $\overline{Q}$ = 0.

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1333333E 03	-0.1000000E 02	0.	0.
0.1434977E 03	-0.1038225E 02	0.9350321E 00	-0.3000000E 00
0.1522405E 03	0.1071105E 02	-0.1714049E 01	0.4000000E-00
0.1647168E 03	-0.1115951E 02	0.2703074E 01	0.5000000E 00
0.1821775E 03	-0.1175713E 02	-0.4232566E 01	0.6000000E 00
0.2066860E 03	0.1254736E 02	-0.6149105E 01	-0.7000000E 00
0.2417021E 03	-0.1160538E 02	-0.9706484E 01	-0.8000000E 00
0.2936264E 03	-0.1503027E 02	0.1217452E 02	-0.9000000E 00
0.3737849E 03	-0.1701631E 02	0.1701631E 02	-0.1000000E 01
0.5083232E 03	0.1991082E 02	0.2409209E 02	0.1100000E 01
0.7603100E 03	0.2444033E 02	0.3519407E 02	0.1200000E 01
0.1326234E 04	-0.3260432E 02	0.5476660E 02	0.1300000E 01
0.3109929E 04	-0.4953153E 02	0.2766972E 02	0.1400000E 01
0.6010707E 04	0.6942748E 02	0.1459713E 03	0.1450000E 01
0.1692918E 05	[illegible] 01	0.2827367E 03	0.1500000E 01
0.1899296E 06	-0.3919990E 03	0.9417775E 03	0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1257105E 03	-0.9658247E 01	0.8678417E 00	0.3000000E 00
0.1177657E 03	0.9374060E 01	0.1429051E 01	0.4000000E 00
0.1101976E 03	-0.9054489E 01	0.2263622E 01	0.5000000E 00
0.1018871E 03	-0.8691620E 01	0.1129906E 01	0.6000000E 00
0.9324190E 02	-0.8297756E 01	0.4265991E 01	0.7000000E 00
0.8457705E 02	0.7[illegible]377E 01	0.5056501E 01	0.8000000E 00
0.7615358E 02	0.7[illegible]961E 01	0.5244107E 01	[illegible]
0.6815729E 02	0.7016915E 01	0.7014915E 01	0.1000000E 01
0.6071157E 02	0.6822570E 01	0.8011119E 01	0.1100000E 01
0.5508391E 02	0.6219249E 01	0.8956277E 01	0.1200000E 01
0.4769830E 02	0.5827857E 01	0.9852425E 01	0.1300000E 01
0.4214690E 02	0.5459949E 01	0.1070155E 02	0.1400000E 01
0.3720040E 02	0.5110257E 01	0.1152303E 02	0.1500000E 01
0.3281475E 02	0.4781527E 01	0.1225044E 02	0.1600000E 01
0.2894607E 02	0.4471502E 01	0.1292163E 02	0.1700000E 01
0.2553685E 02	-0.4186393E 01	0.1356393E 02	0.1800000E 01
0.2253811E 02	0.3919159E 01	0.1414416E 02	0.1900000E 01
0.1990148E 02	0.3670289E 01	0.1468372E 02	0.2000000E 01
0.1750232E 02	0.3440841E 01	0.1517411E 02	0.2100000E 01
0.1554020E 02	0.3227609E 01	0.1562163E 02	0.2200000E 01
0.1373908E 02	0.3052142E 01	0.1602256E 02	0.2300000E 01
0.1213697E 02	0.2847[illegible]E 01	0.1638090E 02	0.2400000E 01
0.1073604E 02	0.2660172E 01	0.1673457E 02	0.2500000E 01
0.9481724E 01	0.2521502E 01	0.1704536E 02	0.2600000E 01
0.8161479E 01	0.2375360E 01	0.1732307E 02	0.2700000E 01
0.7362430E 01	0.2261900E 01	0.1757656E 02	0.2800000E 01
0.6462907E 01	-0.2111207E 01	0.1780571E 02	0.2900000E 01
0.5651530E 01	0.2001493E 01	0.1801144E 02	0.3000000E 01

$\overline{T}_D$ = 0.2000000E 02 $\overline{Q}$ = 0.5000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1095333E 03	-0.9000000E 01	0.5000000E 01	0.
0.1117856E 03	0.9351884E 01	0.1158130E 01	0.3000000E 00
0.1250120E 03	0.9644622E 01	0.1456866E 01	0.4000000E-00
0.1352246E 03	0.1004425E 02	0.4879163E 00	0.5000000E 00
0.1495227E 03	0.1050855E 02	0.8118821E 00	0.6000000E 00
0.1695729E 03	0.1130485E 02	0.2539178E 01	0.7000000E 00
0.1982[illegible] 03	0.1225839E 02	0.4855360E 01	0.8000000E 00
0.2405657E 03	0.1[illegible]E 02	0.7973989E 01	0.9000000E 00
0.3063201E 03	0.1534609E 02	0.1234409E 02	0.1000000E 01
0.4104105E 03	0.1796170E 02	0.1873455E 02	0.1100000E 01
0.6225865E 03	0.2205812E 02	0.2876389E 02	0.1200000E 01
0.1005600E 04	0.2925200E 02	0.4845441E 02	-0.1300000E 01
0.2554920E 04	0.4502335E 02	0.8524574E 02	0.1400000E 01
0.4210226E 04	0.6274766E 02	0.1282264E 03	0.1450000E 01
0.1185094E 05	0.1055708E 03	0.2385338E 03	0.1500000E 01
0.3553088E 06	0.3545150E 03	0.6487224E 03	0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1020707E 03	0.9572977E 01	0.1780568E 01	0.3000000E-00
0.9476586E 02	0.8625172E 01	0.4392468E 01	0.4000000E 00
0.9058029E 02	0.8145501E 01	0.5236125E 01	0.5000000E 00
0.8370214E 02	0.7812356E 01	0.5801274E 01	0.6000000E 00
0.7670784E 02	0.7461302E 01	0.6656030E 01	0.7000000E 00
0.6960250E 02	0.7087710E 01	0.7536152E 01	0.8000000E 00
0.6282959E 02	0.6705485E 01	0.8411767E 01	0.9000000E 00
0.5614553E 02	-0.6325597E 01	0.9232627E 01	0.1000000E 01
0.5006069E 02	0.5987517E 01	0.1019650E 02	0.1100000E 01
0.4444258E 02	0.5542232E 01	0.1103461E 02	0.1200000E 01
0.3936470E 02	0.5231171E 01	0.1184502E 02	0.1300000E 01
0.3543499E 02	0.4597311E 01	0.1259078E 02	0.1400000E 01
0.3074294E 02	0.4541530E 01	0.1332810E 02	0.1500000E 01
0.2711384E 02	0.4284597E 01	0.1396854E 02	0.1600000E 01
0.2375223E 02	0.4006776E 01	0.1457497E 02	0.1700000E 01
0.2114427E 02	0.3747534E 01	0.1514171E 02	0.1800000E 01
0.1867058E 02	0.3530475E 01	0.1565401E 02	0.1900000E 01
0.1649247E 02	0.3253492E 01	0.1611020E 02	0.2000000E 01
0.1457360E 02	0.3376435E 01	0.1656347E 02	0.2100000E 01
0.1268049E 02	0.2882683E 01	0.1695219E 02	0.2200000E 01
0.1113467E 02	0.2705715E 01	0.1743778E 02	0.2300000E 01
0.1205818E 02	0.2540016E 01	0.1761349E 02	0.2400000E 01
0.8579885E 01	0.2386622E 01	0.1792251E 02	0.2500000E 01
0.7829402E 01	-0.2246550E 01	0.1818656E 02	0.2600000E 01
0.6689451E 01	0.2115410E 01	0.1842420E 02	0.2700000E 01
0.6045071E 01	0.1994910E 01	0.1860409E 02	0.2800000E 01
0.5283369E 01	0.1802753E 01	0.1881175E 02	0.2900000E 01
0.4593217E 01	0.1776772E 01	0.1900850E 02	0.3000000E 01

TABLE 1.5-2 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = 0.2000000E 02 $\overline{Q}$ = 0.6000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.8813333E 02	-0.8000000E 01	0.6000000E 01	0.
0.9479897E 02	-0.8314524E 01	0.5251693E 01	-0.3000000E-00
0.1005290E 03	-0.8576190E 01	0.4627810E 01	-0.4000000E-00
0.1087053E 03	-0.8736295E 01	0.3765751E 01	-0.5000000E 00
0.1201506E 03	-0.9419995E 01	0.2603902E 01	-0.6000000E 00
0.1362076E 03	-0.1006035E 02	0.1073429E 01	-0.7000000E 00
0.1571464E 03	-0.1071290E 02	-0.2341751E 00	-0.8000000E 00
0.1750217E 03	-0.1205630E 02	-0.3773452E 01	-0.9000000E 00
0.2456470E 03	-0.1367197E 02	-0.7471868E 01	-0.1000000E 01
0.3337299E 03	-0.1601258E 02	-0.1337522E 02	-0.1100000E 01
0.4986875E 03	-0.1967591E 02	-0.2233331E 02	-0.1200000E 01
0.8691251E 03	-0.2611722E 02	-0.3414159E 02	-0.1300000E 01
0.2036601E 04	-0.4021517E 02	-0.7282172E 02	-0.1400000E 01
0.3935245E 04	0.5606783E 02	-0.1114826E 03	-0.1450000E 01
0.1108140E 05	-0.9436932E 02	-0.2063310E 03	-0.1500000E 01
0.1243107E 06	-0.3170311E 03	-0.7556673E 03	-0.1550000E 01
TENSILE END LOADS			
0.8215571E 02	-0.7707712E 01	0.6693592E 01	0.3000000E-00
0.7792341E 02	-0.7494283E 01	0.7197045E 01	0.4000000E-00
0.7295226E 02	-0.7236112E 01	0.7899028E 01	0.5000000E 00
0.6750567E 02	-0.6943005E 01	0.8499482E 01	0.6000000E 00
0.6103101E 02	-0.6624969E 01	0.9246186E 01	0.7000000E 00
0.5614177E 02	-0.6271058E 01	0.1002624E 02	0.8000000E 00
0.5060706E 02	-0.5949209E 01	0.1081943E 02	0.9000000E 00
0.4555030E 02	-0.5608479E 01	0.1163484E 02	0.1000000E 01
0.4045184E 02	-0.5272460E 01	0.1237768E 02	0.1100000E 01
0.3595590E 02	-0.4946215E 01	0.1312255E 02	0.1200000E 01
0.3187826E 02	-0.4632205E 01	0.1392763E 02	0.1300000E 01
0.2821392E 02	-0.4334655E 01	0.1442592E 02	0.1400000E 01
0.2494380E 02	-0.4052783E 01	0.1511367E 02	0.1500000E 01
0.2206019E 02	0.3787771E 01	0.1569669E 02	0.1600000E 01
0.1947088E 02	0.3539826E 01	0.1625013E 02	0.1700000E 01
0.1720212E 02	-0.3308618E 01	0.1671792E 02	0.1800000E 01
0.1520063E 02	0.3093591E 01	0.1716786E 02	0.1900000E 01
0.1343[illegible]E 02	0.2894010E 01	0.1757404E 02	0.2000000E 01
0.1187553E 02	-0.2709932E 01	0.1794683E 02	0.2100000E 01
0.1049839E 02	-0.2537757E 01	0.1828275E 02	0.2200000E 01
0.9273842E 01	0.2379268E 01	0.1858635E 02	0.2300000E 01
0.8194030E 01	-0.2232654E 01	0.1886009E 02	0.2400000E 01
0.7217073E 01	-0.2097032E 01	0.1910485E 02	0.2500000E 01
0.6350355E 01	0.1971557E 01	0.1932777E 02	0.2600000E 01
0.5570681E 01	0.1855431E 01	0.1952610E 02	0.2700000E 01
0.4866982E 01	-0.1747911E 01	0.1970165E 02	0.2800000E 01
0.4228937E 01	-0.1648794E 01	0.1986219E 02	0.2900000E 01
0.3647661E 01	0.1555950E 01	0.2000355E 02	0.3000000E 01

$\overline{T}_D$ = 0.2000000E 02 $\overline{Q}$ = 0.9000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.6713333E 02	-0.7000000E 01	0.9000000E 01	0.
0.7432602E 02	-0.7277155E 01	0.8365055E 01	-0.3000000E-00
0.7878910E 02	-0.7507758E 01	0.7798759E 01	-0.4000000E-00
0.8515700E 02	-0.7825735E 01	0.7043555E 01	-0.5000000E 00
0.9406743E 02	-0.8251428E 01	0.6029496E 01	-0.6000000E 00
0.1065709E 03	-0.8815844E 01	0.4680237E 01	-0.7000000E 00
0.1244275E 03	-0.9567766E 01	0.2876949E 01	-0.8000000E 00
0.1507932E 03	-0.1055397E 02	0.4270657E-00	-0.9000000E 00
0.1917456E 03	-0.1129964E 02	-0.2797645E 01	-0.1000000E 01
0.2602913E 03	-0.1406546E 02	-0.9016781E 01	-0.1100000E 01
0.3886184E 03	-0.1729370E 02	-0.1590293E 02	-0.1200000E 01
0.6767878E 03	-0.2297577E 02	-0.2292935E 02	-0.1300000E 01
0.1584950E 04	-0.3540678E 02	-0.6037769E 02	-0.1400000E 01
0.3061844E 04	-0.4938803E 02	-0.9483827E 02	-0.1450000E 01
0.8620567E 04	-0.8316906E 02	-0.1781281E 03	-0.1500000E 01
0.9669713E 05	-0.2795472E 03	-0.6626122E 03	-0.1550000E 01
TENSILE END LOADS			
0.6447591E 02	-0.6742447E 01	0.9506420E 01	0.3000000E-00
0.6117790E 02	-0.6554391E 01	0.1004970E 02	0.4000000E-00
0.5710347E 02	0.6376724E 01	0.1058173E 02	0.5000000E 00
0.5305756E 02	-0.6068693E 01	0.1111947E 02	0.6000000E 00
0.4863278E 02	-0.5788436E 01	0.1183653E 02	0.7000000E 00
0.4419553E 02	-0.5494392E 01	0.1251641E 02	0.8000000E 00
0.3987610E 02	-0.5195734E 01	0.1320703E 02	0.9000000E 00
0.3577189E 02	-0.4893262E 01	0.1387326E 02	0.1000000E 01
0.3194502E 02	0.4597402E 01	0.1456296E 02	0.1100000E 01
0.2842973E 02	-0.4310199E 01	0.1523669E 02	0.1200000E 01
0.2523897E 02	-0.4034438E 01	0.1581820E 02	0.1300000E 01
0.2236031E 02	-0.3771993E 01	0.1639311E 02	0.1400000E 01
0.1980315E 02	-0.3521996E 01	0.1692897E 02	0.1500000E 01
0.1752202E 02	0.3290946E 01	0.1742482E 02	0.1600000E 01
0.1542972E 02	-0.3072948E 01	0.17[illegible]3052E 02	0.1700000E 01
0.1371062E 02	-0.2869732E 01	0.1829773E 02	0.1800000E 01
0.1212812E 02	0.2680906E 01	0.1867771E 02	0.1900000E 01
0.1072949E 02	-0.2505520E 01	0.1902238E 02	0.2000000E 01
0.9488509E 01	0.2345127E 01	0.1733319E 02	0.2100000E 01
0.8387897E 01	0.2192832E 01	0.1961330E 02	0.2200000E 01
0.7408372E 01	-0.2053822E 01	0.1986472E 02	0.2300000E 01
0.6533791E 01	-0.1925292E 01	0.2008968E 02	0.2400000E 01
0.5750008E 01	0.1805452E 01	0.2027939E 02	0.2500000E 01
0.5044699E 01	0.1696505E 01	0.2046891E 02	0.2600000E 01
0.4407169E 01	0.1594955E 01	0.2062772E 02	0.2700000E 01
0.3828164E 01	0.1500913E 01	0.2076716E 02	0.2800000E 01
0.3299892E 01	-0.1413944E 01	0.2089043E 02	0.2900000E 01
0.2814061E 01	0.1333178E 01	0.2097860E 02	0.3000000E 01

$\overline{T}_D$ = 0.2000000E 02 $\overline{Q}$ = 0.1200000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = 0.2000000E 02 $\overline{Q}$ = 0.1500000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-2 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = 0.40000000E 01 $\overline{Q}$ = [illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.53333333E 01	0.20000000E 01	0.	0.
0.57543327E 01	0.20779942E 01	0.14703368E-00	-0.10000000E-00
0.61152291E 01	0.21426311E 01	0.34281771E 00	[illegible]
0.66255231E 01	0.22312031E 01	0.55777571E 00	-0.50000000E 00
0.73447031E 01	0.23514761E 01	0.84651371E 00	[illegible]
0.83458401E 01	0.25098711E 01	0.12298371E 01	-0.70000000E 00
0.97705091E 01	0.27227761E 01	0.17412471E 01	-0.80000000E 00
0.11886581E 02	0.30265531E 01	0.24347031E 01	-0.90000000E 00
0.15111521E 02	0.34653261E 01	0.34032631E 01	-0.10000000E 01
0.20526571E 02	0.41821631E 01	0.49184121E 01	0.11000000E 01
0.31642800E 02	0.49962651E 01	0.70509141E 01	-0.12000000E 01
0.53319741E 02	0.66417541E 01	0.10725381E 02	0.13000000E 01
0.12471081E 03	0.92663061E 01	0.19553961E 02	0.14000000E 01
0.24276721E 03	0.13985591E 02	0.22174251E 02	[illegible]
0.67752741E 03	0.23354371E 02	0.52547331E 02	0.15000000E 01
0.25275591E 04	0.78393271E 02	0.11483551E 03	[illegible]
TENSILE END LOADS			
0.47553416E 01	0.12776451E 01	0.17364331E 00	0.30000000E 00
0.47050131E 01	0.14748141E 01	0.22997021E 00	0.40000000E-00
0.43675131E 01	0.14913921E 01	0.45272451E 00	0.50000000E 00
0.42178851E 01	0.17383261E 01	0.62577721E 00	0.60000000E 00
0.38512721E 01	0.18529547E 01	0.81317811E 00	0.70000000E 00
0.35297161E 01	0.15788475E 01	0.10097001E 01	0.80000000E 00
0.29155671E 01	0.16225721E 01	0.12049211E 01	0.90000000E 00
0.25662921E 01	0.14077831E	0.14077431E 01	0.10000000E 01
0.22146631E 01	0.13245151E 01	0.15025541E 01	0.11000000E 01
0.19249571E 01	0.12536501E 01	0.17990551E 01	0.12000000E 01
0.16375321E 01	0.11659671E 01	0.19704851E 01	0.13000000E 01
0.13722781E 01	0.10919961E 01	0.21603121E 01	0.14000000E 01
0.11280261E 01	0.10220511E 01	0.23726181E 01	0.15000000E 01
0.90307711E 00	0.95629481E 00	-0.24460871E 01	0.16000000E 01
0.69584271E 00	0.89671651E 00	0.25957311E 01	0.17000000E 01
0.50307401E 00	0.83727791E 00	-0.27127801E 01	0.18000000E 01
0.32392441E-00	0.78381191E 00	0.29226311E 01	0.19000000E 01
0.15605931E-00	0.73612781E 00	-0.29167211E 01	0.20000000E 01
-0.23071281E 02	0.68918421E 00	0.33146821E 01	0.21000000E 01
0.15277101E 00	0.64552191E 00	0.31243261E 01	0.22000000E 01
0.29683121E 00	0.60503241E 00	0.32059111E 01	0.23000000E 01
0.43572171E 00	0.56947571E 00	0.32901901E 01	0.24000000E 01
0.57355931E 00	0.53561441E 00	0.33477151E 01	0.25000000E 01
0.70232391E 00	0.50430051E 00	0.34290711E 01	0.26000000E 01
0.83138601E 00	0.47527761E 00	0.34667731E 01	0.27000000E 01
0.75920281E 00	0.44931161E 00	0.35153121E 01	0.28000000E 01
-0.10870901E 01	0.42348151E 00	0.35611431E 01	0.29000000E 01
0.12133291E 01	0.40122871E 00	0.36026881E 01	0.30000000E 01

$\overline{T}_D$ = 0.40000000E 01 $\overline{Q}$ = 0.30[illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.11533333E 02	0.30000000E 01	0.30000000E 01	0.
0.12433321E 02	0.31152191E 01	0.32803691E 01	-0.30000000E-00
0.13202121E 02	0.32110431E 01	0.35137671E 01	-0.40000000E-00
0.14332901E 02	0.33431621E 01	0.38357121E 01	-0.50000000E 00
0.15849851E 02	0.35139221E 01	0.42671971E 01	-0.60000000E 00
0.14009201E 02	0.37547721E 01	0.48328641E 01	-0.70000000E 00
0.22024710E 02	0.40664151E 01	0.56024411E 01	-0.80000000E 00
0.25625431E 02	0.44441961E 01	0.66354311E 01	-0.90000000E 00
0.32671531E 02	0.50275461E 01	0.82736061E 01	-0.10000000E 01
0.44446829E 02	0.59312981E 01	0.11176951E 02	-0.11000000E 01
0.68443371E 02	0.72720731E 01	0.13469171E 02	-0.12000000E 01
0.11525281E 03	0.96247801E 01	0.17265881E 02	-0.13000000E 01
0.22171611E 03	0.14776921E 02	0.31257991E 02	-0.14000000E 01
0.53502761E 03	0.20565321E 02	0.46234591E 02	[illegible]
0.14746001E 04	0.34555631E 02	0.85710171E 02	[illegible]
0.32598121E 05	0.11598171E 03	0.28141041E 03	[illegible]
TENSILE END LOADS			
0.11724551E 02	0.28922131E 01	0.22376381E 01	0.30000000E 00
0.11151041E 02	0.28167051E 01	0.21462671E 01	0.40000000E-00
0.96755111E 01	0.27720781E 01	0.25112781E 01	0.50000000E 00
0.87352591E 01	0.26126371E 01	0.23524571E 01	0.60000000E 00
0.79524171E 01	0.24952811E 01	0.17769701E 01	0.70000000E 00
0.71844691E 01	0.23735451E 01	0.16409381E 01	0.80000000E 00
0.64265311E 01	0.22483481E 01	0.11708791E 01	0.90000000E 00
0.57287011E 01	0.21237201E 01	0.47692251E 00	0.10000000E 01
0.50192561E 01	0.19925761E 01	0.53251541E 00	0.11000000E 01
0.43828451E 01	0.18079661E 01	0.22342121E 00	0.12000000E 01
0.37125681E 01	0.17664941E 01	0.18106901E 01	0.13000000E 01
0.32986761E 01	0.16564581E 01	0.12431291E 02	0.14000000E 01
0.28146521E 01	0.15509121E 01	0.21231231E 01	0.15000000E 01
0.23867801E 01	0.14551091E 01	0.21123071E 01	0.16000000E 01
0.20027181E 01	0.13615251E 01	0.23502121E 00	0.17000000E 01
0.16512401E 01	0.12761641E 01	0.11367701E 01	0.18000000E 01
0.13370281E 01	0.11265161E 01	0.13117341E 01	0.19000000E 01
0.10443651E 01	0.11226871E 01	-0.14923751E 01	0.20000000E 01
0.78601511E 00	0.10563731E 01	0.16494621E 01	0.21000000E 01
0.54651451E 00	0.22964771E 00	-0.17237671E 01	0.22000000E 01
0.32100281E-00	0.93147721E 00	0.12275251E 01	0.23000000E 01
0.11270751E 00	0.87683301E 00	0.20505471E 01	0.24000000E 01
0.92837561E 01	0.82629451E 00	0.21637741E 01	0.25000000E 01
0.25775671E 00	0.77927301E 00	0.22678061E 01	0.26000000E 01
0.44390011E 00	0.73575501E 00	0.23636561E 01	0.27000000E 01
0.61285861E 00	0.69511991E 00	0.24511781E 01	0.28000000E 01
-0.77604501E 00	0.65789621E 00	-0.25532951E 01	0.29000000E 01
0.23462201E 02	0.62431161E 00	0.26276331E 01	0.30000000E 01

$\overline{T}_D$ = 0.40000000E 01 $\overline{Q}$ = 0.40000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.20133333E 02	0.40000000E 01	0.40000000E 01	0.
0.21628361E 02	0.41525711E 01	0.43737151E 01	0.10000000E-00
0.23643291E 02	0.42796751E 01	0.45987101E 01	0.40000000E 00
0.24967371E 02	0.44444221E 01	0.51113601E 01	0.50000000E 00
0.27643781E 02	0.45805591E 01	0.55479011E 01	[illegible]
0.31605801E 02	0.47988841E 01	0.64499451E 01	0.70000000E 00
0.36776441E 02	0.54313351E 01	0.86535941E 01	0.80000000E 00
0.44703381E 02	0.59703181E 01	0.12431581E 02	-0.90000000E 00
0.57011121E 02	0.67577031E 01	0.11767711E 02	0.10000000E 01
[illegible]	0.79926031E 01	0.15535291E 02	0.11000000E 01
[illegible]	0.96524901E 01	0.12897571E 02	[illegible]
[illegible]	0.12764301E 02	[illegible]	0.13000000E 01
0.45519641E 03	0.19482671E 02	0.44352381E 02	0.14000000E 01
0.21810662E 04	0.27265141E 02	0.51262211E 03	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = [illegible] $\overline{Q}$ = 0.20000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.31133333E 02	0.50000000E 01	0.90000000E 01	0.
0.33562251E 02	0.51089321E 01	0.94673741E 01	0.30000000E 00
0.35622491E 02	0.53679971E 01	0.99555651E 01	0.40000000E 00
0.38568121E 02	0.55656921E 01	0.10721421E 02	0.50000000E 00
0.42726491E 02	0.58571161E 01	0.11130861E 02	0.60000000E 00
0.48518021E 02	0.62633861E 01	0.12059261E 02	0.70000000E 00
0.56034671E 02	0.67573211E 01	0.13326731E 02	-0.80000000E 00
0.69029451E 02	0.74524511E 01	0.15316401E 02	0.90000000E 00
0.88112581E 02	0.84199721E 01	0.17613931E 02	0.10000000E 01
0.13707801E 03	0.99295241E 01	0.19817201E 02	-0.11000000E 01
0.17984551E 03	0.12034491E 02	0.25129451E 02	0.12000000E 01
0.31552491E 03	0.15311921E 02	0.35473971E 02	0.13000000E 01
[illegible]	0.24593051E 02	0.54802671E 02	0.14000000E 01
0.14227951E 04	0.33925251E 02	0.90317241E 02	0.14500000E 01
[illegible]	[illegible]	0.11711552E 03	[illegible]
0.44264871E 05	[illegible]	0.25752671E 03	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	0.95658901E 01	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.78553881E 01	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-2 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = -0.4000000E 01 $\overline{Q}$ = 0.1200000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.4453333E 02	0.6000000E 01	0.1200000E 02	0.
0.4798206E 02	0.6227293E 01	0.1256046E 02	-0.3000000E-00
0.5094636E 02	0.6416338E 01	0.1302661E 02	-0.4000000E-00
0.5517603E 02	0.6676741E 01	0.1366723E 02	-0.5000000E 00
0.6109806E 02	0.7025692E 01	0.1452725E 02	-0.6000000E 00
0.6940548E 02	0.7497890E 01	0.1566907E 02	-0.7000000E 00
0.8127365E 02	0.8102930E 01	0.1718587E 02	-0.8000000E 00
0.9880062E 02	0.8934584E 01	0.1923701E 02	-0.9000000E 00
0.1260293E 03	0.1009215E 02	0.2209216E 02	-0.1000000E 01
0.1716057E 03	0.1177864E 02	0.2625216E 02	-0.1100000E 01
0.2569627E 03	0.1441690E 02	0.3276033E 02	-0.1200000E 01
0.4486479E 03	0.1905533E 02	0.4420551E 02	-0.1300000E 01
0.1052782E 04	0.2919903E 02	0.6723010E 02	-0.1400000E 01
0.2035283E 04	0.4060479E 02	0.7731157E 02	-0.1450000E 01
0.5733255E 04	0.6815942E 02	0.1653587E 03	-0.1500000E 01
0.6432691E 05	0.2283355E 03	0.5605760E 03	-0.1550000E 01
TENSILE END LOADS			
0.4144039E 02	0.5788700E 01	0.1147902E 02	0.3000000E-00
0.3925103E 02	0.5634384E 01	0.1109850E 02	0.4000000E-00
0.3667904E 02	0.5447651E 01	0.1063809E 02	0.5000000E 00
0.3386095E 02	0.5235572E 01	0.1011519E 02	0.6000000E 00
0.3092480E 02	0.5005281E 01	0.9547412E 01	0.7000000E 00
0.2798101E 02	0.4763514E 01	0.8951351E 01	0.8000000E 00
0.2511693E 02	0.4516276E 01	0.8341817E 01	0.9000000E 00
0.2239629E 02	0.4268653E 01	0.7733347E 01	0.1000000E 01
0.1986061E 02	0.4024750E 01	0.7130053E 01	0.1100000E 01
0.1751268E 02	0.3787715E 01	0.6545691E 01	0.1200000E 01
0.1542055E 02	0.3559833E 01	0.5983983E 01	0.1300000E 01
0.1352152E 02	0.3342645E 01	0.5448416E 01	0.1400000E 01
0.1182561E 02	0.3137080E 01	0.4941570E 01	0.1500000E 01
0.1031816E 02	0.2943583E 01	0.4464427E 01	0.1600000E 01
0.8983023E 01	0.2762229E 01	0.4017157E 01	0.1700000E 01
0.7802006E 01	0.2572821E 01	0.3599259E 01	0.1800000E 01
0.6757991E 01	0.2434969E 01	0.3209761E 01	0.1900000E 01
0.5834543E 01	0.2298156E 01	0.2847376E 01	0.2000000E 01
0.5016423E 01	0.2151787E 01	0.2510618E 01	0.2100000E 01
0.4290090E 01	0.2025225E 01	0.2197710E 01	0.2200000E 01
0.3641077E 01	0.1907819E 01	0.1907635E 01	0.2300000E 01
0.3064610E 01	0.1798925E 01	0.1638194E 01	0.2400000E 01
0.2545210E 01	0.1697915E 01	0.1389034E 01	0.2500000E 01
0.2076572E 01	0.1604191E 01	0.1155671E 01	0.2600000E 01
0.1651532E 01	0.1517187E 01	0.9397043E 00	0.2700000E 01
0.1263857E 01	0.1436375E 01	0.7384234E 00	0.2800000E 01
0.9081797E 00	0.1361252E 01	0.5518083E 00	0.2900000E 01
0.5798691E 00	0.1291385E 01	0.3775307E-00	0.3000000E 01

$\overline{T}_D$ = -0.3000000E 01 $\overline{Q}$ = 0.1500000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.6053333E 02	0.7000000E 01	0.1500000E 02	0.
0.6500131E 02	0.7264656E 01	0.1565382E 02	-0.3000000E-00
0.6907396E 02	0.7486770E 01	0.1619756E 02	-0.4000000E-00
0.7474098E 02	0.7788201E 01	0.1694705E 02	-0.5000000E 00
0.8275845E 02	0.8194258E 01	0.1794993E 02	-0.6000000E 00
0.9400797E 02	0.8732395E 01	0.1927887E 02	-0.7000000E 00
0.1100814E 03	0.9448638E 01	0.2104702E 02	-0.8000000E 00
0.1338219E 03	0.1061372E 02	0.2345754E 02	-0.9000000E 00
0.1707079E 03	0.1176438E 02	0.2676438E 02	-0.1000000E 01
0.2324555E 03	0.1372776E 02	0.3161059E 02	-0.1100000E 01
0.3481085E 03	0.1679210E 02	0.3919071E 02	-0.1200000E 01
0.6073449E 03	0.2219885E 02	0.5751606E 02	-0.1300000E 01
0.1426487E 04	0.3400721E 02	0.8165414E 02	-0.1400000E 01
0.2757861E 04	0.4728461E 02	0.1144159E 03	-0.1450000E 01
0.7768952E 04	0.7936069E 02	0.1935615E 03	-0.1500000E 01
0.8716487E 05	0.2658194E 03	0.6596311E 03	-0.1550000E 01
TENSILE END LOADS			
0.5614741E 02	0.6753973E 01	0.1439214E 02	0.3000000E-00
0.5318494E 02	0.6574276E 01	0.1394812E 02	0.4000000E-00
0.4970505E 02	0.6356840E 01	0.1341079E 02	0.5000000E 00
0.4589288E 02	0.6109883E 01	0.1280044E 02	0.6000000E 00
0.4192203E 02	0.5841714E 01	0.1213756E 02	0.7000000E 00
0.3794182E 02	0.5560173E 01	0.1144169E 02	0.8000000E 00
0.3407073E 02	0.5272251E 01	0.1072960E 02	0.9000000E 00
0.30[illegible]7551E 02	0.4983071E 01	0.1001613E 02	0.1000000E 01
0.2697213E 02	0.4699808E 01	0.9313232E 01	0.1100000E 01
0.2383135E 02	0.4423731E 01	0.8629827E 01	0.1200000E 01
0.2098420E 02	0.4158299E 01	0.7972474E 01	0.1300000E 01
0.1842702E 02	0.3905307E 01	0.7345598E 01	0.1400000E 01
0.1614627E 02	0.3665337E 01	0.6751867E 01	0.1500000E 01
0.1412230E 02	0.3440808E 01	0.6192555E 01	0.1600000E 01
0.1233262E 02	0.3229308E 01	0.5667879E 01	0.1700000E 01
0.1075317E 02	0.3031707E 01	0.5177269E 01	0.1800000E 01
0.9360564E 01	0.2847753E 01	0.4719530E 01	0.1900000E 01
0.8132520E 01	0.2676646E 01	0.4293616E 01	0.2000000E 01
0.7048489E 01	0.2517692E 01	0.3896978E 01	0.2100000E 01
0.6089832E 01	0.2370151E 01	0.3528468E 01	0.2200000E 01
0.5239940E 01	0.2233766E 01	0.3186022E 01	0.2300000E 01
0.4464130E 01	0.2106287E 01	0.2867708E 01	0.2400000E 01
0.3809521E 01	0.1988485E 01	0.2571973E 01	0.2500000E 01
0.3204702E 01	0.1879163E 01	0.2296856E 01	0.2600000E 01
0.2660526E 01	0.1777665E 01	0.2040924E 01	0.2700000E 01
0.2167973E 01	0.1683373E 01	0.1802357E 01	0.2800000E 01
0.1719960E 01	0.1595714E 01	0.1580466E 01	0.2900000E 01
0.1310212E 01	0.1514157E 01	0.1372585E 01	0.3000000E 01

$\overline{T}_D$ = 0.8000000E 01 $\overline{Q}$ = 0.

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.2133333E 02	0.4000000E 01	0.	0.
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = -0.8000000E 01 $\overline{Q}$ = 0.3000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.3253333E 02	0.5000000E 01	0.3000000E 01	0.
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-2 (Cont'd)

VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = -0.8000000E 01 $\overline{Q}$ = 0.6000000E 01

$\overline{r}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.4613333E 02	0.6000000E 01	0.6000000E 01	0.
0.4969063E 02	0.6230420E 01	0.6560738E 01	-0.3000000E-00
0.5274848E 02	0.6422085E 01	0.7027534E 01	-0.4000000E-00
0.5711179E 02	0.6686125E 01	0.7671581E 01	-0.5000000E 00
0.6321941E 02	0.7039984E 01	0.8534394E 01	-0.6000000E 00
0.7178781E 02	0.7508752E 01	0.9679789E 01	-0.7000000E 00
0.8402838E 02	0.8132692E 01	0.1120498E 02	-0.8000000E 00
0.1021047E 03	0.8975172E 01	0.1327386E 02	-0.9000000E 00
0.1301860E 03	0.1015097E 02	0.1615397E 02	-0.1000000E 01
0.1771881E 03	0.1156257E 02	0.2035370E 02	-0.1100000E 01
0.2652132E 03	0.1454055E 02	0.2693939E 02	-0.1200000E 01
0.4628867E 03	0.1924956E 02	0.3853176E 02	-0.1300000E 01
0.1085884E 04	0.2954897E 02	0.6391599E 02	-0.1400000E 01
0.2097059E 04	0.4113064E 02	0.9247717E 02	-0.1450000E 01
0.5912475E 04	0.6911126E 02	0.1615003E 03	-0.1500000E 01
0.6633528E 05	0.2317674E 03	0.5628212E 03	-0.1550000E 01
TENSILE END LOADS			
0.4294318E 02	0.5785827E 01	0.5479276E 01	0.3000000E-00
0.4068431E 02	0.5629412E 01	0.5099294E 01	0.4000000E-00
0.3803104E 02	0.5440172E 01	0.4639757E 01	0.5000000E 00
0.3512384E 02	0.5225274E 01	0.4118701E 01	0.6000000E 00
0.3209471E 02	0.4991961E 01	0.3553359E 01	0.7000000E 00
0.2905740E 02	0.4747070E 01	0.2961875E 01	0.8000000E 00
0.2610220E 02	0.4496636E 01	0.2357676E 01	0.9000000E 00
0.2329480E 02	0.4246001E 01	0.1753299E 01	0.1000000E 01
0.2067802E 02	0.3999148E 01	0.1161031E 01	0.1100000E 01
0.1827538E 02	0.3759332E 01	0.5855623E 00	0.1200000E 01
0.1609519E 02	0.3528868E 01	0.3621381E-01	0.1300000E 01
0.1413470E 02	0.3309316E 01	-0.4862598E-00	0.1400000E 01
0.1238136E 02	0.3101617E 01	-0.9786187E 00	0.1500000E 01
0.1082712E 02	0.2906218E 01	-0.1439917E 01	0.1600000E 01
0.9447870E 01	0.2723189E 01	-0.1870017E 01	0.1700000E 01
0.8227790E 01	0.2552327E 01	-0.2269541E 01	0.1800000E 01
0.7149032E 01	0.2393312E 01	-0.2639569E 01	0.1900000E 01
0.6194864E 01	0.2245375E 01	-0.2981499E 01	0.2000000E 01
0.5349060E 01	0.2108146E 01	-0.3296924E 01	0.2100000E 01
0.4598062E 01	0.1980825E 01	-0.3587534E 01	0.2200000E 01
0.3929039E 01	0.1862950E 01	0.3855269E 01	0.2300000E 01
0.3330830E 01	0.1753676E 01	0.4101173E 01	0.2400000E 01
0.2793650E 01	0.1652409E 01	0.4327556E 01	0.2500000E 01
0.2308973E 01	0.1558546E 01	-0.4535772E 01	0.2600000E 01
0.1869399E 01	0.1471510E 01	0.4727108E 01	0.2700000E 01
0.1468525E 01	0.1390760E 01	0.4903556E 01	0.2800000E 01
0.1100820E 01	0.1315792E 01	0.5065910E 01	0.2900000E 01
0.7615120E 00	0.1246141E 01	0.5215267E 01	0.3000000E 01

$\overline{T}_D$ = -0.8000000E 01 $\overline{Q}$ = 0.7000000E 01

$\overline{r}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.6213333E 02	0.7000000E 01	0.9000000E 01	0.
0.6692707E 02	0.7267781E 01	0.9654100E 01	-0.3000000E-00
0.7104816E 02	0.7490517E 01	0.1019848E 02	-0.4000000E-00
0.7692940E 02	0.7797584E 01	0.1094940E 02	-0.5000000E 00
0.8516280E 02	0.8208551E 01	0.1195508E 02	-0.6000000E 00
0.9671508E 02	0.8753257E 01	0.1328910E 02	-0.7000000E 00
0.1132208E 03	0.9478168E 01	0.1506603E 02	-0.8000000E 00
0.1375991E 03	0.1045850E 02	0.1747139E 02	-0.9000000E 00
0.1754754E 03	0.1182320E 02	0.2087319E 02	-0.1000000E 01
0.2388796E 03	0.1381167E 02	0.2571214E 02	-0.1100000E 01
0.3576337E [illegible]	0.1692275E 02	0.3336876E 02	-0.1200000E 01
0.6243512E [illegible]	0.2239308E 02	0.4684430E 02	-0.1300000E 01
0.1469908E [illegible]	0.3435716E 02	0.7634063E 02	-0.1400000E 01
0.2831948E [illegible]	0.4781046E 02	0.1095215E 03	-0.1450000E 01
0.7977280E 04	0.8011253E 02	0.1997032E 03	-0.1500000E 01
0.8950419E 05	0.2692511E 03	0.6554764E 03	-0.1550000E 01
TENSILE END LOADS			
0.5783490E 02	0.6751092E 01	0.8392402E 01	0.3000000E-00
0.5479188E 02	0.6569305E 01	0.7489118E 01	0.4000000E-00
0.5121793E 02	0.6349361E 01	0.7412660E 01	0.5000000E 00
0.4730266E 02	0.6099586E 01	0.6804149E 01	0.6000000E 00
0.4322425E 02	0.5828195E 01	0.6144086E 01	0.7000000E 00
0.3913610E 02	0.5543730E 01	0.5452013E 01	0.8000000E 00
0.3516005E 02	0.5252672E 01	0.4745336E 01	0.9000000E 00
0.3138471E 02	0.4961218E 01	0.4038782E 01	0.1000000E 01
0.2746788E 02	0.4674207E 01	0.3344210E 01	0.1100000E 01
0.2464120E 02	0.4395340E 01	0.2670679E 01	0.1200000E 01
0.2171524E 02	0.4127534E 01	0.2024306E 01	0.1300000E 01
0.1908641E 02	0.3871970E 01	0.1410922E 01	0.1400000E 01
0.1674467E 02	0.3630174E 01	0.8316476E 00	0.1500000E 01
0.1466465E 02	0.3403254E 01	0.2882111E-00	0.1600000E 01
0.1282559E 02	0.3190068E 01	-0.2192954E-00	0.1700000E 01
0.1120140E 02	0.2991713E 01	-0.6915310E 00	0.1800000E 01
0.9769633E 01	0.2806317E 01	-0.1129720E 01	0.1900000E 01
0.8506892E 01	0.2633964E 01	-0.1535458E 01	0.2000000E 01
0.7392082E 01	0.2474051E 01	-0.1910564E 01	0.2100000E 01
0.6406390E 01	0.2325871E 01	-0.2256975E 01	0.2200000E 01
0.5531866E 01	0.2188405E 01	-0.2576663E 01	0.2300000E 01
0.4754363E 01	0.2061038E 01	-0.2871580E 01	0.2400000E 01
0.4060312E 01	0.1942979E 01	-0.3143619E 01	0.2500000E 01
0.3438285E 01	0.1833519E 01	-0.3394586E 01	0.2600000E 01
0.2878208E 01	0.1731987E 01	-0.3626188E 01	0.2700000E 01
0.2371500E 01	0.1637758E 01	-0.3840072E 01	0.2800000E 01
0.1910670E 01	0.1550246E 01	-0.4037572E 01	0.2900000E 01
0.1489281E 01	[illegible]	-0.4220712E 01	0.3000000E 01

$\overline{T}_D$ = 0.8000000E 01 $\overline{Q}$ = 0.1200000E 02

$\overline{r}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.8053333E 02	0.8000000E 01	0.1200000E 02	0.
0.8674845E 02	0.8305142E 01	0.1274746E 02	0.3000000E 00
0.9269177E 02	0.8558494E 01	0.1336948E 02	0.4000000E 00
0.9917795E 02	0.8708844E 01	0.1422721E 02	0.5000000E 00
0.1103950E 03	0.9377117E 01	0.1537576E 02	0.6000000E 00
0.1255775E 03	0.9997762E 01	0.1689902E 02	0.7000000E 00
0.1467859E 03	0.1092171E 02	0.1892777E 02	0.8000000E 00
0.1704385E 03	0.1196068E 02	0.2167192E 02	0.9000000E 00
0.2275445E 03	0.1369442E 02	0.2554942E 02	0.1000000E 01
0.3028032E 03	0.1576341E 02	0.3137054E 02	0.1100000E 01
0.4438005E 03	0.1939426E 02	0.3972914E 02	0.1200000E 01
0.8039922E 03	0.2555660E 02	0.5515685E 02	0.1300000E 01
0.1900606E 04	0.3918554E 02	0.8974606E 02	0.1400000E 01
0.3674416E 04	0.5449078E 02	0.1265450E 03	0.1450000E 01
0.1035079E 05	0.9151379E 02	0.2177050E 03	0.1500000E 01
0.1161169E 06	0.3087353E 03	0.7484115E 03	0.1550000E 01
TENSILE END LOADS			
0.7495002E 02	0.7715357E 01	0.1110555E 02	0.3000000E 00
0.7101650E 02	0.7502197E 01	0.1029855E 02	0.4000000E 00
0.6610408E 02	0.7250582E 01	0.1113516E 02	0.5000000E 00
0.6133998E 02	0.6971599E 01	0.9659197E 01	0.6000000E 00
0.5602553E 02	0.6684820E 01	0.8716234E 01	0.7000000E 00
0.5072910E 02	0.6360359E 01	0.7962151E 01	0.8000000E 00
0.4557984E 02	0.6008684E 01	0.7132295E 01	[illegible]
0.4069135E 02	0.5675436E 01	0.6123564E 01	0.1000000E 01
0.3611972E 02	0.5349245E 01	0.5527182E 01	0.1100000E 01
0.3196571E 02	0.5011368E 01	0.4755595E 01	0.1200000E 01
0.2815187E 02	0.4725609E 01	0.4213390E 01	[illegible]
0.2470937E 02	0.4436461E 01	0.3351036E 01	[illegible]
0.2176423E 02	0.4159112E 01	0.2581856E 01	[illegible]
0.1905226E 02	0.3899868E 01	0.2018346E 01	[illegible]
0.1671129E 02	0.3656266E 01	0.1511828E 01	[illegible]
0.1462555E 02	0.3430692E 01	0.8086720E 00	[illegible]
0.1278785E 02	0.3213621E 01	0.3901282E 00	[illegible]
0.1117086E 02	0.3022355E 01	0.5901678E 01	[illegible]
0.9760023E 01	0.2845935E 01	[illegible]	[illegible]
0.8457728E 01	0.2679787E 01	0.9268161E 00	[illegible]
0.7372446E 01	0.2515852E 01	0.1205216E 01	[illegible]
0.6196628E 01	[illegible]	0.1551960E 01	[illegible]
0.5521123E 01	[illegible]	0.1256691E 01	[illegible]
0.4752997E 01	0.2108691E 01	[illegible]	[illegible]
0.4062270E 01	0.1992465E 01	0.2525069E 01	[illegible]
0.3413744E 01	[illegible]	[illegible]	[illegible]
0.2885707E 01	0.1786701E 01	0.3024135E 01	[illegible]
0.2329806E 01	0.1691685E 01	0.3225150E 01	[illegible]

$\overline{T}_D$ = 0.8000000E 01 $\overline{Q}$ = 0.1500000E 02

$\overline{r}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.1313333E 03	0.7000000E 01	0.1500000E 02	0.
0.1391547E 03	0.9342503E 01	0.1584007E 02	0.3000000E 00
[illegible]	0.9627181E 01	0.1554038E 02	0.4000000E-00
[illegible]	0.1032018E 02	0.1750503E 02	0.5000000E 00
[illegible]	0.1055560E 02	[illegible]	0.6000000E 00
[illegible]	[illegible]	0.2050871E 02	0.7000000E 00
[illegible]	0.1216922E 02	0.2278817E 02	0.8000000E 00
[illegible]	0.1342277E 02	0.2587244E 02	0.9000000E 00
[illegible]	0.1576768E 02	0.3015764E 02	0.1000000E 01
[illegible]	0.1770994E 02	0.3642913E 02	0.1100000E 01
[illegible]	0.2169717E 02	0.4622952E 02	0.1200000E 01
[illegible]	0.2868011E 02	0.6356739E 02	-0.1300000E 01
[illegible]	0.4397152E 02	0.1011801E 03	0.1400000E 01
[illegible]	0.6117011E 02	0.1436101E 03	0.1450000E 01
[illegible]	0.1027152E 03	0.2461009E 03	0.1500000E 01
[illegible]	0.3462192E 03	0.8419466E 03	0.1550000E 01
TENSILE END LOADS			
0.9432095E 02	[illegible]	[illegible]	0.3000000E 00
0.7915790E 02	[illegible]	[illegible]	[illegible]
0.8352987E 02	[illegible]	0.1295807E 02	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.7591261E 01	0.1112418E 02	[illegible]
[illegible]	0.7117084E 01	0.1043229E 02	[illegible]
[illegible]	[illegible]	0.9520655E 01	[illegible]
[illegible]	0.6391653E 01	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.6815972E 01	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.4887488E 01	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.4521...E 01	[illegible]
[illegible]	[illegible]	0.1998845E 01	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.1823950E 01	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.2019155E 01	0.1781097E 01	0.2900000E 01
[illegible]	[illegible]	0.2210105E 01	0.3000000E 01

TABLE 1.5-2 (Cont'd)

VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

T_D = -0.1200000E 02 $\overline{Q}$ = 0.

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.4800000E 02	0.6000000E 01	0.	0.
0.5166968E 02	0.6733547E 01	0.5610192E 00	-0.3000000E-00
0.5482365E 02	0.6427832E 01	0.1028453E 01	-0.4000000E 00
0.5932400E 02	0.6695708E 01	0.1673927E 01	-0.5000000E 00
0.6562303E 02	0.7054277E 01	0.2533954E 01	-0.6000000E 00
0.7445922E 02	0.7529615E 01	0.3689511E 01	-0.7000000E 00
0.8708125E 02	0.8162329E 01	0.5223890E 01	-0.9000000E 00
0.1057193E 03	0.9018160E 01	0.7304710E 01	-0.9000000E 00
0.1346707E 03	0.1020979E 02	0.1020779E 02	-0.1000000E 01
0.1831254E 03	0.1194649E 02	0.1445525E 02	-0.1100000E 01
0.2738652E 03	0.1466420E 02	0.2111644E 02	-0.1200000E 01
0.4776244E 03	0.1944379E 02	0.3286001E 02	-0.1300000E 01
0.1119784E 04	0.2999892E 02	0.5860190E 02	-0.1400000E 01
0.2164108E 04	0.4165649E 02	0.8758276E 02	-0.1450000E 01
0.6094746E 04	0.7006311E 02	0.1576420E 03	-0.1500000E 01
0.6937483E 05	0.2351294E 03	0.5650665E 03	-0.1550000E 01
TENSILE END LOADS			
0.4470907E 02	0.5782945E 01	-0.5204650E 00	0.3000000E-00
0.4237845E 02	0.5624441E 01	-0.8999105E 00	0.4000000E-00
0.3964086E 02	0.5432693E 01	0.1358173E 01	0.5000000E 00
0.3664097E 02	0.5214977E 01	-0.1877397E 01	0.6000000E 00
0.3351485E 02	0.4778642E 01	0.2439534E 01	0.7000000E 00
0.3037980E 02	0.4730623E 01	-0.3027601E 01	0.8000000E 00
0.2732892E 02	0.4477116E 01	-0.3626404E 01	0.9000000E 00
0.2442998E 02	0.4223347E 01	-0.4223349E 01	0.1000000E 01
0.2172710E 02	0.3973545E 01	-0.4807991E 01	0.1100000E 01
0.1924461E 02	0.3730949E 01	-0.5372566E 01	0.1200000E 01
0.1699112E 02	0.3497907E 01	-0.5911455E 01	0.1300000E 01
0.1496384E 02	0.3275999E 01	-0.6420336E 01	0.1400000E 01
0.1315222E 02	0.3066154E 01	-0.6898948E 01	0.1500000E 01
0.1154093E 02	0.2868052E 01	-0.7344261E 01	0.1600000E 01
0.1011232E 02	0.2684149E 01	-0.7757192E 01	0.1700000E 01
0.8347666E 01	0.2511834E 01	0.9118361E 01	0.1800000E 01
0.7728652E 01	0.2351496E 01	0.8689899E 01	0.1900000E 01
0.6737866E 01	0.2202593E 01	-0.8810373E 01	0.2000000E 01
0.5859716E 01	0.2064505E 01	0.9104466E 01	0.2100000E 01
0.5070207E 01	0.1936565E 01	0.9372977E 01	0.2200000E 01
0.4381789E 01	0.1818097E 01	0.9617734E 01	0.2300000E 01
0.3758509E 01	0.1700427E 01	-0.9840541E 01	0.2400000E 01
0.3198110E 01	0.1606903E 01	-0.1004514E 02	0.2500000E 01
0.2692426E 01	0.1512903E 01	-0.1022721E 02	0.2600000E 01
0.2233255E 01	0.1425833E 01	0.1039432E 02	0.2700000E 01
0.1814200E 01	0.1345145E 01	-0.1054593E 02	0.2800000E 01
0.1479609E 01	0.1270374E 01	-0.1066383E 02	0.2900000E 01
0.1074551E 01	0.1200876E 01	-0.1080906E 02	0.3000000E 01

$\overline{T}_D$ = -0.1200000E 02 $\overline{Q}$ = 0.3000000E 01

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.6420000E 02	0.7000000E 01	0.3000000E 01	0.
0.6912311E 02	0.7270900E 01	0.3654307E 01	-0.3000000E 00
0.7135562E 02	0.7496264E 01	0.4199402E 01	-0.4000000E-00
0.7737488E 02	0.7806968E 01	0.4951742E 01	-0.5000000E 00
0.8784941E 02	0.8272843E 01	0.5960224E 01	-0.6000000E 00
0.9971128E 02	0.8774117E 01	0.7227318E 01	-0.7000000E 00
0.1166532E 03	0.9507867E 01	0.9085035E 01	-0.9000000E 00
0.1416867E 03	0.1050029E 02	0.1153524E 02	-0.9000000E 00
0.1805708E 03	0.1188291E 02	0.1484201E 02	-0.1000000E 01
0.2456586E 03	0.1389561E 02	0.1981369E 02	0.1100000E 01
0.3675604E 03	0.1704640E 02	0.2754632E 02	-0.1200000E 01
0.6413175E 03	0.2258731E 02	0.4117255E 02	-0.1300000E 01
0.1504124E 04	0.3470710E 02	0.7102591E 02	-0.1400000E 01
0.2907307E 04	0.4833631E 02	0.1046271E 03	-0.1450000E 01
0.8188658E 04	0.8126437E 02	0.1859448E 03	-0.1500000E 01
0.9161066E 05	0.2726833E 03	0.6581216E 03	-0.1550000E 01
TENSILE END LOADS			
0.5978548E 02	0.6748213E 01	0.2392661E 01	0.3000000E 00
0.5665946E 02	0.6564333E 01	0.1942707E 01	0.4000000E 00
0.5299863E 02	0.6341882E 01	0.1414553E 01	0.5000000E 00
0.4896642E 02	0.6349298E 01	0.4078562E 00	0.6000000E 00
0.4477579E 02	0.5815075E 01	0.1576133E-03	0.7000000E 00
0.4037639E 02	0.5527286E 01	-0.5374630E 00	0.8000000E 00
0.3649063E 02	0.5233392E 01	-0.1238805E 01	0.9000000E 00
0.3261046E 02	0.4938556E 01	0.1939566E 01	0.1000000E 01
0.2899525E 02	0.4648605E 01	0.2624912E 01	0.1100000E 01
0.2567759E 02	0.4357965E 01	0.3284430E 01	0.1200000E 01
0.2266901E 02	0.4076369E 01	-0.3922863E 01	0.1300000E 01
0.1996576E 02	0.3838650E 01	0.4523754E 01	0.1400000E 01
0.1755362E 02	0.3594912E 01	-0.5088551E 01	0.1500000E 01
0.1541202E 02	0.3365677E 01	0.5516133E 01	0.1600000E 01
0.1351706E 02	0.3151029E 01	0.6136470E 01	0.1700000E 01
0.1184371E 02	0.2950720E 01	0.6560311E 01	0.1800000E 01
0.1036728E 02	0.2764280E 01	-0.6972950E 01	0.1900000E 01
0.9064344E 01	0.2591083E 01	0.7364332E 01	0.2000000E 01
0.7913284E 01	0.2430409E 01	0.7718106E 01	0.2100000E 01
0.6894520E 01	0.2281491E 01	0.8082418E 01	0.2200000E 01
0.5990579E 01	0.2143594E 01	0.8139367E 01	0.2300000E 01
0.5186028E 01	0.2015739E 01	0.8512967E 01	0.2400000E 01
0.4467323E 01	0.1597473E 01	0.8852208E 01	0.2500000E 01
0.3822686E 01	0.1787874E 01	0.9086328E 01	0.2600000E 01
0.3241876E 01	0.1686311E 01	0.9291200E 01	0.2700000E 01
0.2716040E 01	0.1592143E 01	-0.9482501E 01	0.2800000E 01
0.2237529E 01	0.1504779E 01	0.9655191E 01	0.2900000E 01
0.1797764E 01	0.1423668E 01	-0.9811010E 01	0.3000000E 01

T_D = 0.1200000E 02 Q = 0.6000000E 01

T	y	M	λ
COMPRESSIVE END LOADS			
[illegible]	0.8000000E 01	0.6000000E 01	0.
0.8718169E 02	[illegible]	0.6747744E 01	-0.3000000E 00
[illegible]	[illegible]	0.7370351E 01	-0.4000000E 00
[illegible]	0.8918270E 01	0.8228557E 01	-0.5000000E 00
[illegible]	[illegible]	0.9363907E 01	-0.6000000E 00
[illegible]	[illegible]	0.1090913E 02	-0.7000000E 00
[illegible]	[illegible]	0.1294610E 02	-0.8000000E 00
[illegible]	[illegible]	0.1570576E 02	-0.9000000E 00
[illegible]	[illegible]	0.1955523E 02	-0.1000000E 01
[illegible]	[illegible]	0.2517212E 02	-0.1100000E 01
[illegible]	[illegible]	[illegible]	-0.1200000E 01
[illegible]	[illegible]	[illegible]	-0.1300000E 01
[illegible]	[illegible]	[illegible]	-0.1400000E 01
[illegible]	[illegible]	[illegible]	-0.1450000E 01
[illegible]	[illegible]	[illegible]	-0.1500000E 01
[illegible]	[illegible]	[illegible]	-0.1550000E 01
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

T_D = 0.1200000E 02 Q = 0.9000000E 01

T	y	M	λ
COMPRESSIVE END LOADS			
[illegible]	0.9000000E 01	0.9000000E 01	0.
[illegible]	[illegible]	[illegible]	[illegible]
TENSILE END LOADS			
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-2 (Cont'd)

VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = -0.1200000E 02 $\overline{Q}$ = 0.1200000E 02

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1272000E 03	0.1000000E 02	0.1200000E 02	0.
0.1369936E 03	0.1058299E 02	0.1293447E 02	-0.3000000E-00
0.1454143E 03	0.1070156E 02	0.1371225E 02	-0.4000000E-00
0.1574331E 03	0.1114075E 02	0.1478519E 02	-0.5000000E 00
0.1742616E 03	0.1172854E 02	0.1622228E 02	-0.6000000E 00
0.1978776E 03	0.1250763E 02	0.1812874E 02	-0.7000000E 00
0.2316259E 03	0.1355448E 02	0.2066947E 02	-0.8000000E 00
0.2814796E 03	0.1494669E 02	0.2413692E 02	-0.9000000E 00
0.3589494E 03	0.1689386E 02	0.2889468E 02	-0.1000000E 01
0.4886504E 03	0.1974227E 02	0.3588499E 02	-0.1100000E 01
0.7316038E 03	0.2419303E 02	0.4683796E 02	-0.1200000E 01
0.1277273E 04	0.3201796E 02	0.6511018E 02	0.1300000E 01
0.2997198E 04	0.4913164E 02	0.1094294E 03	-0.1400000E 01
0.5794343E 04	0.6837578E 02	0.1557501E 03	0.1450000E 01
0.1632263E 05	0.1148692E 03	0.2704536E 03	-0.1500000E 01
0.1631413E 06	0.3851351E 03	0.7572470E 03	-0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1184199E 03	0.9644005E 01	0.1113204E 02	[illegible]
0.1122051E 03	0.9384011E 01	0.1047856E 02	[illegible]
0.1049075E 03	0.9069447E 01	0.9732538E 01	[illegible]
0.9691478E 02	0.8712229E 01	0.8863166E 01	[illegible]
0.8859155E 02	0.8326375E 01	0.7921056E 01	[illegible]
0.8025176E 02	0.7917765E 01	0.6932952E 01	[illegible]
0.7218510E 02	0.7501029E 01	0.5922417E 01	[illegible]
0.6445232E 02	0.7084219E 01	0.4915753E 01	[illegible]
0.5729108E 02	0.6673741E 01	0.3924725E 01	[illegible]
0.5022865E 02	0.6275014E 01	[illegible]	[illegible]
0.4478563E 02	0.5891768E 01	[illegible]	[illegible]
0.3945516E 02	0.5526657E 01	[illegible]	[illegible]
0.3470495E 02	0.5191193E 01	[illegible]	[illegible]
0.3052563E 02	0.4856151E 01	[illegible]	[illegible]
0.2679777E 02	0.4555842E 01	[illegible]	[illegible]
0.2355523E 02	0.4267377E 01	[illegible]	[illegible]
0.2066870E 02	0.4002633E 01	[illegible]	[illegible]
0.1815185E 02	0.3756552E 01	[illegible]	[illegible]
0.1594098E 02	0.3578178E 01	[illegible]	[illegible]
0.1399711E 02	[illegible]	[illegible]	[illegible]
0.1228567E 02	[illegible]	[illegible]	[illegible]
0.1027517E 02	[illegible]	[illegible]	[illegible]
0.9439755E 01	[illegible]	[illegible]	[illegible]
0.8256122E 01	[illegible]	[illegible]	[illegible]
0.7199229E 01	[illegible]	[illegible]	[illegible]
0.6257159E 01	[illegible]	[illegible]	[illegible]
0.5417437E 01	0.2208142E 01	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = -0.1200000E 02 $\overline{Q}$ = [illegible]

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1539000E 03	0.1100000E 02	0.1500000E 02	0.
0.1647870E 03	0.1142035E 02	0.1602783E 02	[illegible]
0.1749218E 03	0.1176279E 02	0.1688320E 02	[illegible]
0.1893877E 03	0.1225201E 02	0.1806300E 02	[illegible]
0.2096433E 03	0.1287711E 02	0.1964296E 02	[illegible]
0.2380698E 03	0.1375214E 02	0.2173855E 02	[illegible]
0.2786940E 03	0.1487002E 02	0.2452961E 02	[illegible]
0.3387075E 03	0.1642982E 02	0.2830735E 02	[illegible]
0.4319682E 03	0.1857090E 02	0.3357090E 02	[illegible]
0.5881118E 03	0.2169209E 02	0.4124763E 02	[illegible]
0.8860043E 03	0.2657523E 02	0.5326834E 02	[illegible]
0.1557550E 04	0.3516138E 02	0.7442273E 02	[illegible]
0.3608230E 04	0.5393282E 02	0.1207221E 03	[illegible]
0.6975901E 04	0.7505560E 02	0.1729044E 03	[illegible]
0.1965137E 05	0.1260694E 03	0.2986562E 03	[illegible]
0.2204925E 06	0.4226170E 03	0.1030382E 04	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1424332E 03	0.1060927E 02	0.1404516E 02	[illegible]
0.1349542E 03	0.1032390E 02	0.1334817E 02	[illegible]
0.1261722E 03	0.9978635E 01	0.1250534E 02	[illegible]
0.1105544E 03	0.9506535E 01	0.1154889E 02	[illegible]
0.1065398E 03	0.9160809E 01	0.1051120E 02	[illegible]
0.9650574E 02	[illegible]	[illegible]	[illegible]
0.8675304E 02	0.8256996E 01	[illegible]	[illegible]
[illegible]	0.7794361E 01	[illegible]	[illegible]
0.5888315E 02	[illegible]	0.6107924E 01	[illegible]
[illegible]	0.6911230E 01	0.5068116E 01	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
0.3562699E 02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = [illegible] $\overline{Q}$ = [illegible]

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = [illegible] $\overline{Q}$ = [illegible]

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-2 (Cont'd)

VALUES OF $\overline{\lambda}$. $\overline{y}$ AND $\overline{M}$ FOR S. ECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = 0.1600000E 02 $\overline{Q}$ = 0.6000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1301333E 03	0.1000000E 02	0.6000000E 01	0.
0.1401115E 03	0.1038612E 02	0.6954753E 01	-0.3000000E-01
0.1486909E 03	0.1070731E 02	0.7715169E 01	-0.4000000E 00
0.1509354E 03	0.1115015E 02	0.8787533E 01	-0.5000000E 00
0.1780794E 03	0.1174708E 02	0.1022742E 02	-0.6000000E 00
0.2021373E 03	0.1252350E 02	0.1213896E 02	-0.7000000E 00
0.2365152E 03	0.1355731E 02	0.1468749E 02	-0.8000000E 00
0.2872969E 03	0.1498848E 02	0.1814067E 02	-0.9000000E 00
0.3667052E 03	0.1695750E 02	0.2295750E 02	-0.1000000E 01
0.4983094E 03	0.1982489E 02	0.2999054E 02	-0.1100000E 01
0.7457561E 03	0.2451668E 02	0.4101631E 02	-0.1200000E 01
0.1301503E 04	0.3221209E 02	0.5043943E 02	0.1300000E 01
0.3555165E 04	0.4968159E 02	0.1029837E 03	0.1400000E 01
0.5201949E 04	0.6090163E 02	0.1503657E 03	0.1450000E 01
0.1662438E 05	0.1158200E 03	[illegible] 03	0.1500000E 01
0.1065127E 06	0.3805570E 03	0.9125123E 03	0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = -0.1600000E 02 $\overline{Q}$ = 0.7000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
0.1561333E 03	0.1100000E 02	0.9000000E 01	0.
0.1681220E 03	0.1162348E 02	0.1002811E 02	-0.3000000E 00
0.1784306E 03	0.1177574E 02	0.1088412E 02	-0.4000000E-00
0.1931433E 03	0.1226139E 02	0.1206535E 02	-0.5000000E 00
0.2137441E 03	0.1291140E 02	0.1364310E 02	-0.6000000E 00
0.2426542E 03	0.1377300E 02	0.1574877E 02	-0.7000000E 00
0.2839680E 03	0.1491272E 02	0.1854862E 02	-0.8000000E 00
0.3449978E 03	0.1647061E 02	0.2234119E 02	-0.9000000E 00
0.4378348E 03	0.1862772E 02	0.2762772E 02	-0.1000000E 01
0.5986124E 03	0.2177601E 02	0.3534898E 02	-0.1100000E 01
0.8960373E 03	0.2669388E 02	0.4744639E 02	-0.1200000E 01
0.1564020E 04	0.3535561E 02	0.6875078E 02	-0.1300000E 01
0.3669524E 04	0.5428977E 02	0.1154079E 03	[illegible] 01
0.7093778E 04	0.7550145E 02	0.1679100E 03	[illegible] 01
0.1298222E 05	0.1270213E 03	0.2947778E 03	[illegible] 01
0.2241779E 06	0.4260509E 03	0.1032597E 04	0.1550000E 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = [illegible]

[illegible]

TABLE 1.5-2 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = -0.2000000E 02 $\overline{Q}$ = 0.

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	0.	0.
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

$\overline{T}_D$ = -0.2000000E 02 $\overline{Q}$ = 0.1000000E 01

COMPRESSIVE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	0.1100000E 02	0.3000000E 01	0.
[illegible]	0.1162666E 02	0.4028135E 01	-0.1000000E-00
[illegible]	0.1178169E 02	0.4885059E 01	[illegible]
[illegible]	[illegible]	0.6067594E 01	[illegible] 00
[illegible]	[illegible]	0.7653250E 01	[illegible] 00
[illegible]	[illegible]	[illegible]	[illegible] 00
[illegible]	[illegible]	0.1256763E 02	[illegible]
[illegible]	0.1651740E 02	[illegible]	[illegible]
[illegible]	[illegible]	0.2168854E 02	[illegible] 01
[illegible]	[illegible]	[illegible]	[illegible] 01
[illegible]	[illegible]	0.4182445E 02	[illegible] 01
[illegible]	[illegible]	[illegible]	[illegible] 01
[illegible]	[illegible]	[illegible]	[illegible] 01
[illegible]	[illegible]	[illegible]	[illegible] 01
[illegible]	[illegible]	[illegible]	[illegible] 01
[illegible]	[illegible]	[illegible]	[illegible] 01

TENSILE END LOADS

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 1.5-2 (Cont'd)
VALUES OF $\overline{\lambda}$, $\overline{y}$ AND $\overline{M}$ FOR SPECIFIED VALUES OF $\overline{T}_d$, $\overline{T}$ AND $\overline{Q}$

$\overline{T}_D$ = -0.2000000E 02 $\overline{Q}$ = 0.1200000E 02

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.2525383E 03	0.1400000E 02	0.1200000E 02	0.
0.2710202E 03	0.1453869E 02	0.1316884E 02	-0.3000000E-00
0.2885900E 03	0.1488476E 02	0.1449708E 02	-0.4000000E-00
0.3173850E 03	0.1560455E 02	0.1590114E 02	-0.5000000E 00
0.3457033E 03	0.1665139E 02	0.1771530E 02	-0.6000000E 00
0.3924632E 03	0.1752758E 02	0.2056884E 02	-0.7000000E 00
0.4792089E 03	0.1898605E 02	0.2415106E 02	-0.8000000E 00
0.5560113E 03	0.2095980E 02	0.2897663E 02	-0.9000000E 00
0.7114286E 03	0.2370571E 02	0.3570521E 02	-0.1000000E 01
0.9682041E 03	0.2770730E 02	0.4552583E 02	-0.1100000E 01
0.1469467E 04	0.3396216E 02	0.6091558E 02	-0.1200000E 01
0.2550202E 04	0.4498039E 02	0.8801088E 02	-0.1300000E 01
0.5736686E 04	0.6906425E 02	0.1473659E 03	-0.1400000E 01
0.1147687E 05	0.9814677E 02	0.2141486E 03	-0.1450000E 01
0.5232922E 05	0.2315769E 03	0.3755480E 03	-0.1500000E 01
0.3627329E 06	0.5419347E 03	0.1113778E 04	-0.1550000E 01
TENSILE END LOADS			
0.2351542E 03	0.1349950E 02	0.1078506E 02	0.3000000E-00
0.2278527E 03	0.1313366E 02	0.9398616E 01	0.4000000E-00
0.2054092E 03	0.1269174E 02	0.8827139E 01	0.5000000E 00
0.1925917E 03	0.1218897E 02	0.7612005E 01	0.6000000E 00
0.1761719E 03	0.1164367E 02	0.6296730E 01	0.7000000E 00
0.1596220E 03	0.1107102E 02	0.4914550E 01	0.8000000E 00
0.1435856E 03	0.1048576E 02	0.3506533E 01	0.9000000E 00
0.1283770E 03	0.9892785E 01	0.2100215E 01	0.1000000E 01
0.1147154E 03	0.9322812E 01	0.7193777E 00	0.1100000E 01
0.1012443E 03	0.8762315E 01	-0.6177307E 00	0.1200000E 01
0.8950430E 02	0.8273703E 01	-0.1998057E 01	0.1300000E 01
0.7898036E 02	0.7710628E 01	-0.3112331E 01	0.1400000E 01
0.6961650E 02	0.7225786E 01	-0.4256893E 01	0.1500000E 01
0.6133079E 02	0.6768720E 01	-0.5327722E 01	0.1600000E 01
0.5402940E 02	0.6341073E 01	-0.6325765E 01	0.1700000E 01
0.4761518E 02	0.5941733E 01	-0.7251867E 01	0.1800000E 01
0.4196454E 02	0.5570277E 01	-0.8108771E 01	0.1900000E 01
0.3705093E 02	0.5224947E 01	-0.8899770E 01	0.2000000E 01
0.3272675E 02	0.4904440E 01	-0.9628670E 01	0.2100000E 01
0.2893513E 02	0.4607315E 01	-0.1029939E 02	0.2200000E 01
0.2560650E 02	0.4331749E 01	-0.1071601E 02	0.2300000E 01
0.2260000E 02	0.4070829E 01	-0.1146253E 02	0.2400000E 01
0.2010216E 02	0.3840452E 01	-0.1200283E 02	0.2500000E 01
0.1782637E 02	0.3621393E 01	-0.1246061E 02	0.2600000E 01
0.1501218E 02	0.3418729E 01	-0.1[illegible]937E 02	0.2700000E 01
0.1402457E 02	0.3229501E 01	-0.13[illegible]242E 02	0.2800000E 01
0.1243332E 02	0.3055025E 01	-0.1369276E 02	0.2900000E 01
0.1101235E 02	0.2892590E 01	-0.1403322E 02	0.3000000E 01

$\overline{T}_D$ = -0.2000000E 02 $\overline{Q}$ = 0.1500000E 0[illegible]

$\overline{T}$	$\overline{y}$	$\overline{M}$	$\overline{\lambda}$
COMPRESSIVE END LOADS			
0.2093353E 03	0.1500000E 02	0.1500000E 02	0.
0.[illegible]106877E 03	0.1557605E 02	0.1640184E 02	-0.3000000E-00
0.3295380E 03	0.1605521E 02	0.1756865E 02	-0.4000000E-00
0.3567299E 03	0.1671589E 02	0.1917895E 02	-0.5000000E 00
0.3946063E 03	0.1759796E 02	0.2133599E 02	-0.6000000E 00
0.4482451E 03	0.1877183E 02	0.2419822E 02	-0.7000000E 00
0.5246174E 03	0.2043157E 02	0.2801221E 02	-0.8000000E 00
0.6374458E 03	0.2244093E 02	0.3317715E 02	-0.9000000E 00
0.8127876E 03	0.2537743E 02	0.4037743E 02	-0.1000000E 01
0.1106367E 04	0.2965642E 02	0.5083426E 02	-0.1100000E 01
0.1656322E 04	0.3635136E 02	0.6734596E 02	-0.1200000E 01
0.2891560E 04	[illegible]12391E 02	0.9632940E 02	-0.1300000E 01
0.6785062E 04	[illegible]87244E 02	0.1597900E 03	-0.1400000E 01
0.1311728E 05	0.1028266E 03	0.2311929E 03	-0.1450000E 01
0.3695100E 05	0.1727782E 03	0.4037509E 03	-0.1500000E 01
0.4145934E 06	0.5794196E 03	0.1407053E 04	-0.1550000E 01
TENSILE END LOADS			
0.2684730E 03	0.1466457E 02	0.1369819E 02	0.3000000E-00
0.2546129E 03	0.1407353E 02	0.1274823E 02	0.4000000E-00
0.2379128E 03	0.1360043E 02	0.1159089E 02	0.5000000E 00
0.2198390E 03	0.1306319E 02	0.1029725E 02	0.6000000E 00
0.2010207E 03	0.1247990E 02	0.8984847E 01	0.7000000E 00
0.1821657E 03	0.1186768E 02	0.7406608E 01	0.8000000E 00
0.1638475E 03	0.1124174E 02	0.5894191E 01	0.9000000E 00
0.1464675E 03	0.1061500E 02	0.4384990E 01	0.1000000E 01
0.1302964E 03	0.9997870E 01	0.2902577E 01	0.1100000E 01
0.1154811E 03	0.9398329E 01	0.1466406E 01	0.1200000E 01
0.1020737E 03	0.8822169E 01	0.9053450E-01	0.1300000E 01
0.9005689E 02	0.8273270E 01	-0.1215649E 01	0.1400000E 01
0.7936649E 02	0.7754043E 01	-0.2446597E 01	0.1500000E 01
0.6990950E 02	0.7265544E 01	-0.3599793E 01	0.1600000E 01
0.6157794E 02	0.680[illegible]3E 01	-0.4675043E 01	0.1700000E 01
0.5425869E 02	0.6380[illegible]2E 01	-0.5673852E 01	0.1800000E 01
0.4784020E 02	0.5983081E 01	-0.6598922E 01	0.1900000E 01
0.4221665E 02	0.5613437E 01	-0.7453749E 01	0.2000000E 01
0.3729038E 02	0.5270365E 01	-0.8242110E 01	0.2100000E 01
0.3297289E 02	0.4952238E 01	-0.8968834E 01	0.2200000E 01
0.2918574E 02	0.4657396E 01	-0.9637623E 01	0.2300000E 01
0.2565709E 02	0.4384170E 01	-0.1025273E 02	0.2400000E 01
0.2292906E 02	0.4131022E 01	-0.1081889E 02	0.2500000E 01
0.2034608E 02	0.3896565E 01	-0.1133945E 02	0.2600000E 01
0.1806250E 02	0.3678775E 01	-0.1181427E 02	0.2700000E 01
0.1603829E 02	0.3476899E 01	-0.1225809E 02	0.2800000E 01
0.1423087E 02	0.3289440E 01	-0.1266453E 02	0.2900000E 01
0.1263445E 02	0.3115152E 01	-0.1304317E 02	0.3000000E 01

1.5 (Cont'd)

CASE C – Transverse load uniformly distributed or concentrated at midspan – specified axial loads (zero axial end restraint):

The beam is shown schematically in Figure 1.5-3. Since the ends are unrestrained axially, the beam ends are free to move due to the action of temperature, transverse loads and specified end loads. Hence the compatibility Eqs. (2) and (5) do not apply, and since λ is now a known quantity, the maximum deflections and bending moments may be determined directly from Eqs. (3) and (6). These quantities are independent of the average temperature in the beam.

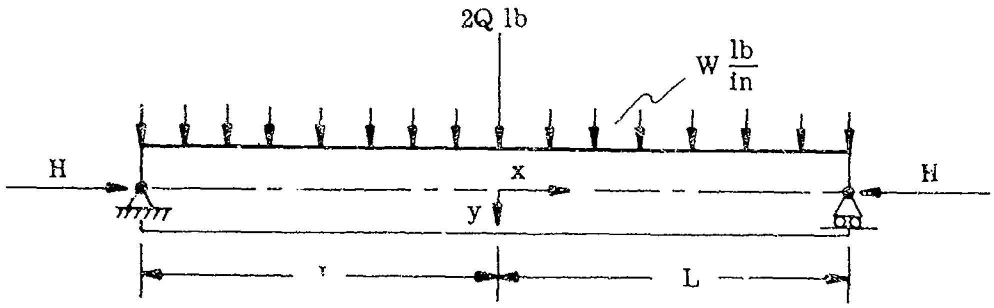
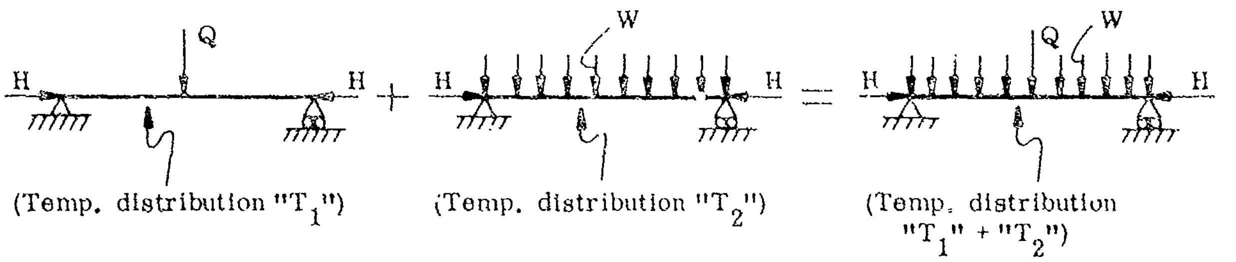
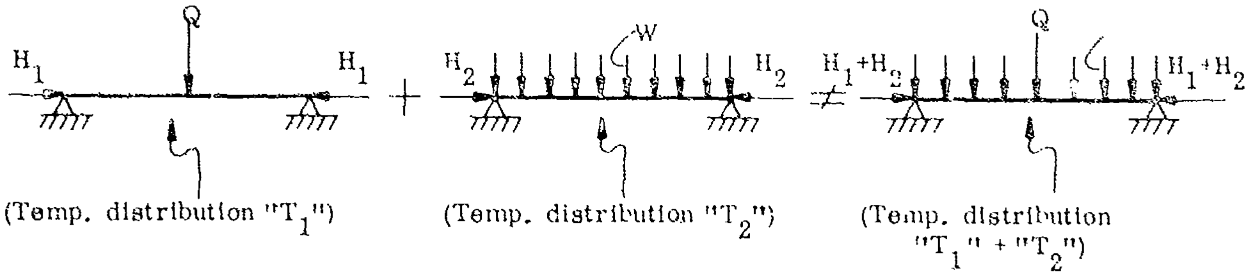


FIGURE 1.5-3. RECTANGULAR BEAM WITH ZERO AXIAL END RESTRAINT AND SPECIFIED AXIAL LOADS

It is important to note that when the end loadings are specified then a modified principle of superposition as shown by Figure 1.5-4a may be used. The figure shows that the resultant effect of several transverse loads and temperature distributions acting simultaneously



(a) Superposition valid for an axially unrestrained beam with specified end loads "H"



(b) Superposition not valid for an axially restrained beam

FIGURE 1.5-4 MODIFIED SUPERPOSITION PRINCIPLE

in the presence of a specified axial load can be obtained by superposing the effects of the individual transverse loads and temperatures acting with the axial load.

However, this superposition principle is <u>not</u> valid when the ends are restrained axially (e.g., Cases A and B). In such cases the axial loads depend on the transverse loads and temperatures nonlinearly.

1.6 USE OF THE TABLES

Tables 1.5-1 and 1.5-2 are reproductions of IBM 7090 digital computer numerical solutions for the beam-column problem. Table 1.5-1 presents results for the case of uniform transverse loading and Table 1.5-2 applies for concentrated midspan loads. Each table is first subdivided into sections corresponding to given temperature differences and transverse loads and then further subdivided into compressive and tensile end loading cases. Since the quantities $\overline{W}$, $\overline{T}_d$, and $\overline{T}$ specified in a given problem will not in general coincide with those listed in the tables, interpolation must be employed. The important quantity to be evaluated is the nondimensional end loading parameter, $\overline{\lambda}$ and the spacing of the tabulated values has been made sufficiently close so as to allow reasonably accurate interpolation for engineering purposes. A systematic interpolation formula will be given as part of an illustrative problem in Sub-section 1.7.

Numerical values are given in terms of a floating decimal number system and are to be interpreted as shown by the following examples

$$0.2456582\text{E }00 = 0.2456582 \times 10^{0} = 0.2456582$$

$$0.2456582\text{E }02 = 0.2456582 \times 10^{2} = 24.56582$$

$$0.2456582\text{E-}01 = 0.2456582 \times 10^{-1} = 0.02456582$$

1.7 NUMERICAL EXAMPLES

EXAMPLE I - <u>Beam with Full Axial End Restraint:</u>

Figure 1.7-1 shows a simply supported strip with immovable ends subjected to a uniformly distributed load of $2\frac{\text{lb.}}{\text{in.}}$. The temperature varies linearly through the thickness from 100° F at the upper face to 150° F at the lower face. Young's modulus and the linear coefficient of thermal expansion are taken to be

$$E = 30 \times 10^{6} \text{ psi}$$

$$\alpha = 6 \times 10^{-6} \text{ in/in - °F.}$$

Find the axial end load, midspan deflection, bending moment and the maximum stress.

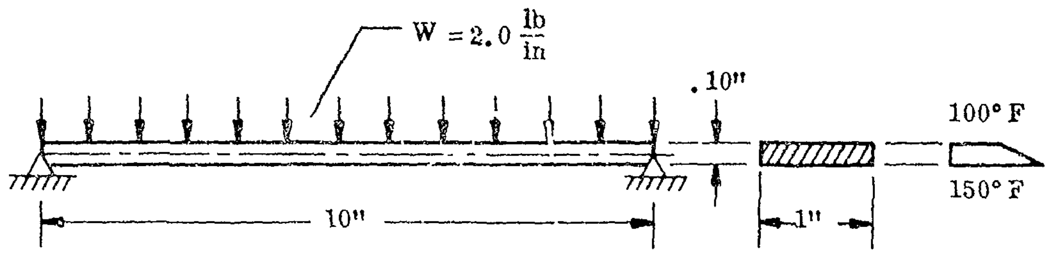


FIGURE 1.7-1 ILLUSTRATIVE PROBLEM; STRIP WITH IMMOVABLE ENDS

SOLUTION

From Figure 1.7-1 and the given data:

$b = 1''$	$T_o = 100°F$
$h = 0.10''$	$T_i = 150°F$
$L = 5''$	$E = 30 \times 10^6$ psi
$W = 2.0 \frac{lb}{in}$	$\alpha = 6 \times 10^{-6}$ in/in - °F

Therefore

$$\overline{W} = \frac{12W}{Eb}\left(\frac{L}{h}\right)^4 = \frac{12\,(2.0)}{(30)\,(10)^6\,(1)}\left(\frac{5}{0.10}\right)^4 = \underline{5.0}$$

$$\overline{T}_d = \alpha\left(\frac{L}{h}\right)^2 (T_o - T_i) = 6\,(10)^{-6}\left(\frac{5}{0.10}\right)^2 (100-150) = \underline{-0.75}$$

$$\overline{T} = \alpha\left(\frac{L}{h}\right)^2 (T_o + T_i) = 6\,(10)^{-6}\left(\frac{5}{0.10}\right)^2 (100+150) = \underline{3.75}$$

Using the above nondimensional quantities we must now utilize Table 1.5-1 to determine the nondimensional axial loading parameter $\overline{\lambda}$. Since the table does not give $\overline{\lambda}$ directly for the above combination of quantities the following interpolation procedure is recommended:

(1) Determine the next lower and higher values of $\overline{W}$ that are given in the table. Designate these values as $\overline{W}_0$ and $\overline{W}_1$ respectively. For this example

$\overline{W}_0 = 3.0$ and

$\overline{W}_1 = 6.0$.

1.7 (Cont'd)

(2) Determine the next lower and higher values of $\overline{T}_d$ that are given in the table. Designate these values as $\overline{T}_{d0}$ and $\overline{T}_{d1}$, respectively.

For this example

$$\overline{T}_{d0} = -4.0 \quad \text{and}$$

$$\overline{T}_{d1} = 0.$$

(3) For each of the four combinations $(\overline{W}_0, \overline{T}_{d0})$, $(\overline{W}_0, \overline{T}_{d1})$, $(\overline{W}_1, \overline{T}_{d0})$, $(\overline{W}_1, \overline{T}_{d1})$ the table lists $\overline{\lambda}$'s corresponding to $\overline{T}$'s on either side of the given value for $\overline{T}$. Denote the values of $\overline{T}$ listed in the tables for the combination $(\overline{W}_i, \overline{T}_{dj})$ by $(\overline{T}_{ij}, \overline{T}'_{ij})$ and the corresponding values of $\overline{\lambda}$ by $(\overline{\lambda}_{ij}, \overline{\lambda}'_{ij})$ where $\overline{T}_{ij} < \overline{T} < \overline{T}'_{ij}$

For this example

$\overline{T}_{00} = 3.397$	$\overline{\lambda}_{00} = 1.2$
$\overline{T}'_{00} = 3.896$	$\overline{\lambda}'_{00} = 1.1$
$\overline{T}_{01} = 3.041$	$\overline{\lambda}_{01} = -1.2$
$\overline{T}'_{01} = 5.174$	$\overline{\lambda}'_{01} = -1.3$
$\overline{T}_{10} = 3.416$	$\overline{\lambda}_{10} = 1.5$
$\overline{T}'_{10} = 3.969$	$\overline{\lambda}'_{10} = 1.4$
$\overline{T}_{11} = 3.648$	$\overline{\lambda}_{11} = -.8$
$\overline{T}'_{11} = 4.441$	$\overline{\lambda}'_{11} = -.9$

(4) The value of $\overline{\lambda}$ may now be obtained from the following interpolation formula.

$$\overline{\lambda} = \left[\frac{\overline{W} - \overline{W}_0}{\overline{W}_1 - \overline{W}_0}\right] A + \left[\frac{\overline{W}_1 - \overline{W}}{\overline{W}_1 - \overline{W}_0}\right] B$$

1.7 (Cont'd)

where

$$A = \left[\frac{\overline{T}_d - \overline{T}_{d0}}{\overline{T}_{d1} - \overline{T}_{d0}}\right] \left[\frac{\left(\overline{T} - \overline{T}_{11}\right)\overline{\lambda}'_{11} + \left(\overline{T}'_{11} - \overline{T}\right)\overline{\lambda}_{11}}{\overline{T}'_{11} - \overline{T}_{11}}\right]$$

$$+ \left[\frac{\overline{T}_{d1} - \overline{T}_d}{\overline{T}_{d1} - \overline{T}_{d0}}\right] \left[\frac{\left(\overline{T} - \overline{T}_{10}\right)\overline{\lambda}'_{10} + \left(\overline{T}'_{10} - \overline{T}\right)\overline{\lambda}_{10}}{\overline{T}'_{10} - \overline{T}_{10}}\right]$$

$$B = \left[\frac{\overline{T}_d - \overline{T}_{d0}}{\overline{T}_{d1} - \overline{T}_{d0}}\right] \left[\frac{\left(\overline{T} - \overline{T}_{01}\right)\overline{\lambda}'_{01} + \left(\overline{T}'_{01} - \overline{T}\right)\overline{\lambda}_{01}}{\overline{T}'_{01} - \overline{T}_{01}}\right]$$

$$+ \left[\frac{\overline{T}_{d1} - \overline{T}_d}{\overline{T}_{d1} - \overline{T}_{d0}}\right] \left[\frac{\left(\overline{T} - \overline{T}_{00}\right)\overline{\lambda}'_{00} + \left(\overline{T}'_{00} - \overline{T}\right)\overline{\lambda}_{00}}{\overline{T}'_{00} - \overline{T}_{00}}\right]$$

Substituting the known quantities into the above formula yields

$$\overline{\lambda} = -.524$$

Thus the axial end load is given by

$$H = \frac{EI\overline{\lambda}^2}{L^2} = \frac{(30\,(10)^6[(1)\,(.10)^3/12]\,(-.524)^2}{(5)^2} = 27.4 \text{ lb. (compression)}$$

The nondimensional deflection and bending moment at midspan can be determined from Table 1.5-1 using an identical interpolation procedure. However, a simpler and more accurate method is to substitute the known values of $\overline{\lambda}$, $\overline{W}$, and $\overline{T}_d$ into Eqs. (3a) of Subsection 1.5*). Direct substitution yields

$$\overline{y} = \left[\frac{y}{h}\right]_{x=0} = 1.60 \quad \text{and}$$

$$\overline{M} = \left[\frac{12ML^2}{Ebh^4}\right]_{x=0} = 2.94\ ,$$

so that

$$y\Big]_{x=0} = h\,\overline{y}$$

$$= (.10)\,(1.60) = .16 \text{ in. (downward)}$$

$$M\Big]_{x=0} = \frac{Ebh^4}{12L^2}\,\overline{M}$$

$$= \frac{30\,(10)^6\,(1)\,(.10)^4}{12\,(5)^2}\,(2.94)$$

$$= 29.4 \text{ in.-lb} \quad \text{(compression in upper fiber)}$$

---

* Eqs. (3b) are not to be used here since they apply only for $\overline{\lambda} > 0$ (tension)

The maximum stress is thus

$$\sigma_{max} = \frac{H}{bh} + \frac{M(6)}{bh^2} = 17,900 \text{ psi.}$$

The effect of axially restraining the beam is evidenced by comparing these results with those for an axially unrestrained and simply supported beam subjected to the same transverse loading and temperature but with H = 0. In such a case the central deflection, bending moment and maximum stress are given by (Section 4 of Reference 1-2):

$$y\Big]_{x=0} = \frac{5W(2L)^4}{384EI} + \frac{\alpha(T_i - T_0)L^2}{2h}$$

$$= .104 + .038$$

$$= .142 \text{ in}$$

$$M\Big]_{x=0} = \frac{W(2L)^2}{8} = 25 \text{ in-lb.}$$

$$\sigma_{max} = 15,000 \text{ psi .}$$

Thus, in this case, neglecting axial end restraint which may be present yields unconservative results for both the central deflection and maximum stress.

EXAMPLE II - Unrestrained Beam Column With Prescribed Axial Load:

Figure 1.7-2 shows a simply supported strip with movable ends and a prescribed 20 lb tensile load subjected to a concentrated midspan load of 10 lbs. The temperature varies linearly through the thickness from 200° F at the upper face to 150° F at the bottom face. Young's modulus and the linear coefficient of thermal expansion are given as

$$E = 30 \times 10^6 \text{ psi}$$

$$\alpha = 6 \times 10^{-6} \text{ in/in - °F}$$

Find the midspan deflection, bending moment and the maximum stress.

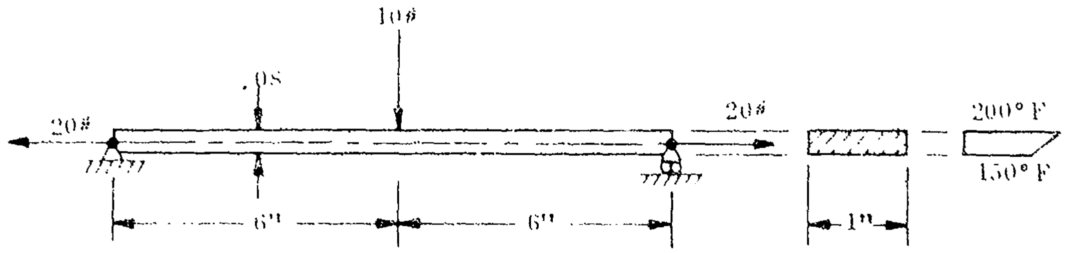


FIGURE 1.7-2 ILLUSTRATIVE PROBLEM; STRIP WITH MOVABLE ENDS

1.7 (Cont'd)

SOLUTION

From Figure 1.7-2 and the given data:

$b = 1''$ $\qquad T_o = 200°F$

$h = .08''$ $\qquad T_i = 150°F$

$L = 6''$

$Q = 5$ lb $\qquad E = 30 \times 10^6$ psi

$H = 20$ lb $\qquad \alpha = 6 \times 10^{-6}$ in/in - °F

Therefore

$$\bar{Q} = \frac{12QL^3}{Ebh^4} = \frac{(12)(5)(6)^3}{30(10)^6(1)(.08)^4} = 10.55$$

$$\bar{T}_d = \alpha\left(\frac{L}{h}\right)^2 (T_o - T_i) = 6(10)^{-6}\left(\frac{6}{.08}\right)^2 (200 - 150) = 1.69$$

$$\bar{\lambda} = \sqrt{\frac{HL^2}{EI}} = \sqrt{\frac{20(6)^2}{(30)(10)^6(1)(.08)^3/12}} = .75$$

As discussed in Sub-section 1.5, since the ends are free to move, the bending response of the beam is independent of the average temperature. The central deflection* and bending moment can thus be obtained by direct substitution of the nondimensional parameters into Eqs. (6b) of Sub-section 1.5. This yields

$$\bar{y} = \left[\frac{y}{h}\right]_{x=0} = .674$$

$$M = \left[\frac{12ML^2}{Ebh^4}\right]_{x=0} = 2.94$$

so that

$$y\Big]_{x=0} = .054 \text{ in (downward)}$$

$$M\Big]_{x=0} = 26.5 \text{ in-lb (compression in upper fiber).}$$

* This is not always the maximum deflection (see Sub-section 1.8)

1.8 ADDITIONAL CONSIDERATIONS

(1) Application of Basic Equations to the Case of Unequal Elastic End Restraints.

The general formulas presented in Sub-section 1.3 have been developed for the case of equal elastic end restraints of stiffness 2K (Figure 1.3-1). As is frequently the case, these restraints may be unequal. This situation can be accomodated by replacing the quantity 2K in Sub-section 1.3 with the equivalent quantity $\frac{4K_1K_2}{K_1 + K_2}$ where $2K_1$ and $2K_2$ are the unequal spring stiffnesses. Thus for example in the special case where one end is held ($K_1 = \infty$) then

$$\lim_{K_1 \to \infty} \frac{4K_1K_2}{K_1 + K_2} = 4K_2;$$

and this quantity is to be substituted for 2K in Eqs. (3) and (4) of Sub-section 1.4. This procedure will yield the correct results for the deflection and bending moment.

(2) Maximum Bending Moments and Deflections.

This report presents results for the determination of the central deflection and bending moment for a symmetrically loaded beam-column. It can be shown by the usual maximum-minimum procedure that the central bending moment is always numerically the largest bending moment in the beam. If the temperatures and loads tend to produce curvatures in the same direction then the central deflection is a maximum. However where temperature and loads tend to relieve each other, the central deflection may not be a maximum. If this quantity is desired it may be found by considering the full deflection formula (Eq. (1) of Sub-section 1.4).

1.9 REFERENCES

1-1 Timoshenko, S., "Theory of Elastic Stability," McGraw Hill Book Company, Inc. pp. 6-8, 1936.

1-2 Switzky, H., Forray, M., and Newman, M., "Thermo-Structural Analysis Manual"-Volume I, Sections 1, 2, and 4 of Republic Aviation Corporation Report No. RAC 679-1, September 1960, revised November 1961 (to be published as WADD TR 60-517, Vol. I).

SECTION 2

APPROXIMATE SOLUTION FOR AN AXIALLY RESTRAINED COLUMN SUBJECTED TO ELEVATED TEMPERATURES AND LATERAL LOADS

by

H. Switzky

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APPROXIMATE SOLUTION FOR AN AXIALLY RESTRAINED COLUMN SUBJECTED TO ELEVATED TEMPERATURES AND LATERAL LOADS

2.1 SUMMARY

Approximate solutions are obtained for the axial compressive load and the lateral deflections of columns which are restrained by an axial spring and subjected to an increase in temperature. The solutions are presented graphically in terms of nondimensional parameters.

The problem considered is a column of arbitrary cross section with pinned or clamped ends subjected to an arbitrary temperature and lateral load distribution in addition to finite initial eccentricities. The effects of the thermal gradients, lateral loads, non-linear axial springs, and plasticity of the material are discussed. The simpler problem of constant bending stiffness is explored to illustrate the evaluation of the nondimensional parameters.

2.1.1 Definition of Symbols

The following symbols are used throughout this section:

a	Amplitude of lateral deflection, inches
b	Axial extension parameter $(b = \alpha T/\epsilon_1)$
b	Width of rectangular cross section, inches
d	Axial shortening parameter $\left(d_i = \frac{\Delta_1}{\ell \epsilon_1}\right)$
h	Depth of cross section of column, inches
i	Integer indicating order of the deformation mode
k	Axial stiffness of end restraint, pounds per inch
ℓ	Length of column, inches
m_j	Coefficients expressing the lateral deformation as a polynomial, inches
q	Lateral load, pounds per inch
r	Force function. Ratio of axial load in column to a reference load $(r(x) = F(x)/F_o)$
w	Lateral deflection of column, inches
x	Axial coordinate of column, inches
z	Lateral coordinate of column cross section, inches
α	Coefficient of thermal (linear) expansion, inches per inch-°F
Δ	Deflection of ends of column, inches
Δ	Incremental change
ϵ	Axial strain due to axial load or temperature, inches per inch
ϵ_i	Buckling strain corresponding to i^{th} mode $\left(\epsilon_i = \lambda_i \rho^2\right)$
π	Load parameter $\left(\pi_1 = \frac{F}{F_1}\right)$
κ	Curvature of column, 1/inches
λ_i	Eigenvalue for which non-trivial solutions of the differential equilibrium equation exist $\left(\lambda_i = \frac{F_i}{EI}\right)$, 1/sq. inches

μ_i	Eigenvalue ($\mu_i = \tan \mu_i$)
ξ	Nondimensional axial coordinate ($\xi = x/\ell$)
ρ	Effective radius of gyration $= \sqrt{\overline{EI}/\overline{EA}}$, inches
σ	Axial stress ($\sigma = F/A$), psi
ϕ	Stiffness function. Ratio of bending stiffness of cross section to a reference bending stiffness $\left(\phi(x) = \dfrac{EI\,(x)}{E_o I_o} \right)$
φ_i	Additional axial shortening function $\left(\varphi_i = \left(\dfrac{1}{1 - \eta_i} \right)^2 - 1 \right)$
Φ	Nondimensional linear axial shortening term $\left(\Phi = 1 + \dfrac{EA}{k\ell} + 2 \sum \dfrac{\eta_i d_i}{\eta_i} \right)$
A	Cross sectional area, sq. inches
C	Amplitude of curvature ($\kappa = \Sigma C_i \kappa_i$)
E_s	Secant modulus ($E_s = \sigma/\epsilon = E$ for a linear material), psi
$\overline{EA}$	Axial stiffness ($\overline{EA} = \int E_s \, dA$, note $\int E_s \, z \, dA = 0$), lb
$\overline{EI}$	Bending stiffness ($\overline{EI} = \int E_s \, z^2 \, dA$), pounds square inches
F	Axial load in column, lb
I	Moment of inertia of cross sections, inches^4
L	Half length of column ($L = \ell/2$), inches
M	Moment ($M = EI\,w''$), pounds per inch
P	Redundant transverse load, lb
T	Temperature increment from datum, °F

SUBSCRIPTS

o	Condition before application of axial load
i	i^{th} mode
q	Due to lateral mechanical loads
T	Due to temperature
s.s.	Simple simple boundary conditions
s.c.	Simple clamped boundary conditions
c.c.	Clamped clamped boundary conditions
s	Symmetrical mode
a	Anti-symmetrical mode

2.1.2 GENERAL APPROACH

The analysis of the problem is approached by examining the deformation characteristics of the column with a linear material to obtain a solution which satisfies compatibility and equilibrium. The following steps are employed to solve the column shown in Figure 2.1.2-1.

(1) The column deforms in characteristic modes which are dependent upon the distribution of the bending stiffness and axial load in the column as well as the boundary (end) con

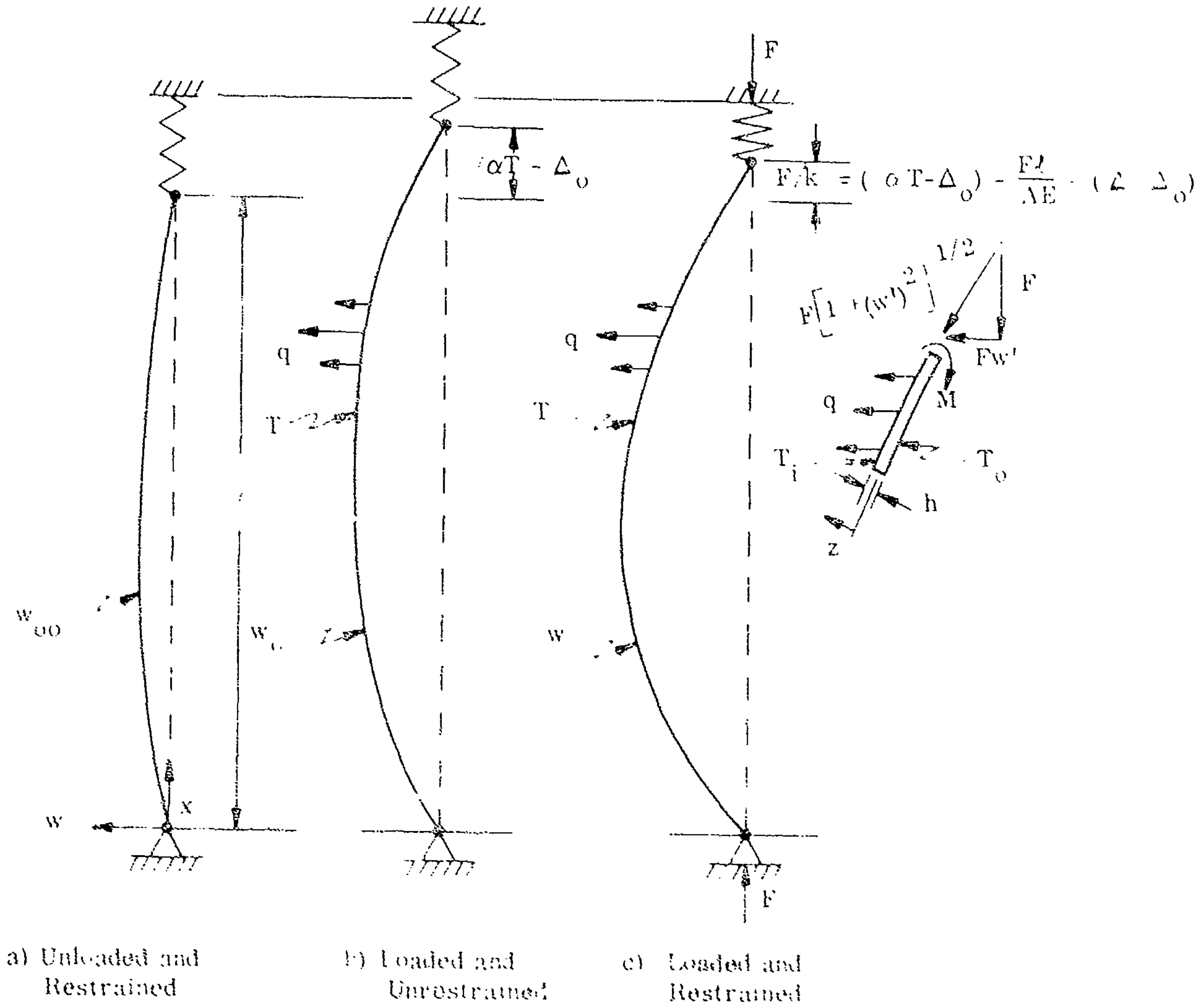


FIGURE 2.1.2-1 RESTRAINED COLUMN

ditions. Basic orthogonality relationships exist among the characteristic deformation modes which are used in obtaining a solution for the column in a thermal and mechanical environment.

(2) The deformations of a column subjected to lateral loadings and temperature gradients in addition to an axial load are then determined by solving the equilibrium equation. The analysis results in a solution in terms of the "initial" deformations caused by the lateral loads, thermal gradients, and manufacturing and loading eccentricities acting on a column with no axial load. These "initial" deformations grow with the magnitude of the axial load. Each characteristic deformation mode is magnified as a rectangular hyperbola, by a factor $\left(\frac{1}{1 - r_i}\right)$ which is a function of the applied load and the characteristic "buckling" load corresponding to the deformation mode. The method of determining deformation modes and corresponding buckling loads is illustrated for columns of constant bending stiffness with pinned or clamped ends.

(3) The axial load is then expressed as the solution of a compatibility equation which considers the thermal expansion, the lateral deflection, and the axial deformation of a restraining spring. The axial load determined by this method satisfies both the equilibrium and compatibility conditions of the structure. The solution is, therefore, correct for a reversible (one to one relationship of load and deformation) structure even though a column deforms non-linearly with load.

(4) The compatibility equation is quite difficult to solve but a simple and reasonable approximation of the additional axial shortening of the column due to the axial load reduces the compatibility equation to a form which can be readily solved by graphical means.

(5) The solutions of the axial load and deformation of columns are presented for pinned (simple) or clamped ends simplified by applicable formulae and graphs together with a computational procedure and illustrative problems. The techniques to obtain the "initial" deformations due to lateral load and thermal gradients, and the effective stiffness of the restraining spring are also presented. The effects of nonlinearity in the spring or material are discussed.

2.2 ANALYSIS

The mathematical relationships necessary to solve the problem are derived in Reference 2-1. The results are summarized below.

2.2.1 Relationships of Deformation Modes

Various orthogonality relationships exist between the characteristic deflection modes and their derivatives whenever the boundary conditions are natural (e.g., free, clamped, simple, etc.). These relationships are useful in evaluating the initial and final lateral deformations as well as the axial shortening in terms of these characteristic modes.

Orthogonality relationships, (see Section 1A of Reference 2-1) are obtained by solving the homogeneous differential equilibrium equation

$$(\rho w'')'' + \lambda(rw')' = 0 \tag{1}$$

2.2.1 (Cont'd)

where

φ	is the ratio of bending stiffness to a reference bending stiffness ($E_o I_o$)
w	is the lateral deflection
r	is the ratio of the axial load in the cross section to the reference load (F_o)
λ	is the eigenvalue $\frac{F_o}{E_o I_o}$.

The following orthogonality relationships are derived

$$\int_o^{\ell} (rw_i')' \, w_k \, dx = 0 \qquad i \neq k \qquad (2)$$

Thus the characteristic modes, which are the solutions to the differential equilibrium equation, are orthogonal to the derivative of the weighted slope $\left[(r\,w')'\right]$. For end loads ($r = 1$), the deflection and curvature modes are orthogonal. This relationship permits the determination of the amplitudes of the deflection modes for the lateral deflections caused by the lateral load and thermal gradients and permits the determination of the growth of these modes when the column is compressed.

$$\int_o^{\ell} rw_i' \, w_k' dx = 0 \qquad i \neq k \qquad (3)$$

Similarly, the slopes of the deflection modes are orthogonal with respect to a load weighting factor (r). This relationship permits the rapid determination of the axial shortening of the column in terms of the magnitude of the deformation modes.

$$\int_o^{\ell} \varphi \, w_i'' \, w_k'' \, dx = 0 \qquad i \neq k \qquad (4)$$

The orthogonality of the curvature with respect to the stiffness weighting function (φ), permits the solution of the non-homogeneous differential equilibrium equation resulting from the initial deformations due to the lateral load and thermal gradients. The effect of the lateral load and temperature can be expressed as initial curvatures which grow as a rectangular hyperbola with an increase in axial load as indicated in Figure 2.2.1-1.

2.2.2 Solution of Non-Homogeneous Differential Equilibrium Equation

The homogeneous differential equilibrium equation can be rewritten as a function of the curvature ($\varkappa = w''$)

i.e. $\quad (\varphi\varkappa)'' + \lambda\, r\, \varkappa = 0 \qquad (1)$

The solutions of this equation results in eigenvectors of the curvature which are orthogonal with respect to the weighting function φ (Eq. (4) of Paragraph 2.2.1). It is assumed that these curvature modes form a closed set for the "natural" boundary conditions (columns of constant EI ($\varphi = 1$) result in Fourier expansions). Thus, any curvature can be expressed as a weighted sum of the eigenvectors.

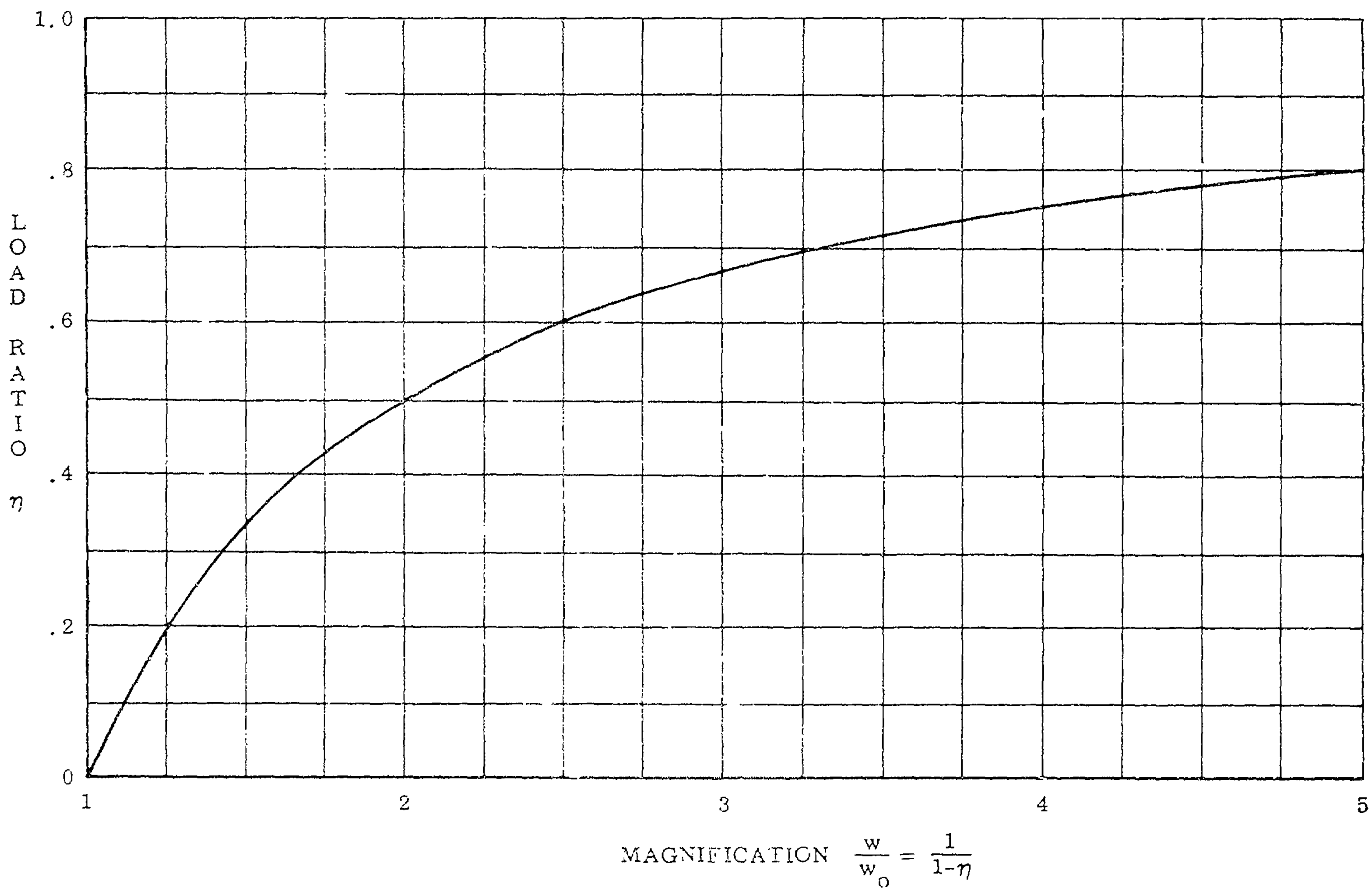


FIGURE 2.2.1-1 MAGNIFICATION OF DEFORMATION MODES

2.2.2 (Cont'd)

i.e. $$\varkappa = \sum C_i \, \varkappa_i \tag{2a}$$

where $$(\varphi \varkappa_i)'' + \lambda_i \, r \, \varkappa_i = 0 \tag{2b}$$

If the unrestrained column is not straight because of initial eccentricities, thermal gradients, and lateral loads, then the moment acting on the column is proportional to the change in curvature and the equilibrium equation becomes, for an end loaded column ($r = 1$),

$$(\varphi \varkappa)'' + \lambda \varkappa = \left[\varphi \, (\varkappa_q + \varkappa_T) \right]'' \tag{3}$$

where $\varkappa_q$ is the curvature caused by the lateral load and $\varkappa_T$ is the curvature caused by the thermal gradient.

Expressing the solution as a weighted sum of the characteristic curvatures (Eq. (2a)) which satisfy the homogeneous equation and manipulating Eq. (3) results in the solution for the curvature of an axially loaded column in terms of the initial curvature and the load ratio.

$$\varkappa = \sum \frac{b_i}{1 - \eta_i} \, \varkappa_i \tag{4}$$

where $b_i \varkappa_i$ corresponds to the i^{th} component of the initial curvature of the column due to the lateral load and temperature. Thus the column deforms under axial load by having each component of the initial curvature increase by a magnification factor $1/(1-\eta_i)$. Correspondingly the slopes and lateral deflection modes increase by this same factor.

Since the initial deformations are expressible as an infinite series of the characteristic curvatures, it becomes expeditious to employ the initial curvatures and to integrate this infinite series to obtain the expression for the slope which is employed in obtaining the axial shortening. Employing the initial slope or lateral deflection will result in a slower convergence of the series expressing the axial shortening and would reduce the accuracy of the approximate procedure employed to solve the compatibility equation.

2.2.3 <u>Determination of Deformation Modes and Buckling Loads</u>

The deflection modes (w) of the column are obtained by solving the homogeneous equilibrium Eq. (1) of Paragraph 2.2.1. The buckling loads (F_i) are those values of the axial load which result in non-trivial solutions of the equation. The technique of obtaining these items is illustrated for a column of constant bending stiffness ($\varphi = 1$).

The homogeneous equilibrium equation for constant bending stiffness (EI) is

$$\frac{d^4 w}{dx^4} + \frac{F}{EI} \frac{d^2 w}{dx^2} = w^{IV} + \lambda w'' = 0 \tag{1}$$

The general solution is

$$w = c_1 + c_2 x + c_3 \cos\sqrt{\lambda}\, x + c_4 \sin\sqrt{\lambda}\, x \tag{2}$$

where c_1, c_2, c_3, c_4 are constants to be determined by the boundary conditions.

Solutions for various boundary conditions can be found in various texts. The simple-simple, clamped-clamped, and simple-clamped are summarized below. In addition the method of determining the magnitude of the initial curvature modes is indicated.

(1) Simple-Simple Column

The boundary conditions are

$$w(0) = w(\ell) = 0$$

$$w''(0) = w''(\ell) = 0$$

$$\therefore\ w_i = a_i \sin \frac{i\pi x}{\ell} = a_i \sin \sqrt{\lambda_i}\, x \tag{3a}$$

where $w = \sum w_i$

$$\frac{F_i}{EI} = \lambda_i = \left(\frac{i\pi}{\ell}\right)^2 \tag{4a}$$

$$\varkappa_i = \sin \frac{i\pi x}{\ell} \tag{5a}$$

$$\int_0^{\ell} \varkappa_i^{\,2}\, dx = \ell/2$$

$$C_i = \frac{\int_0^{\ell} w''\varkappa_i\, dx}{\int_0^{\ell} \varkappa_i^{\,2}\, dx} = \frac{2}{\ell}\int_0^{\ell} w'' \sin \frac{i\pi x}{\ell}\, dx \tag{6a}$$

where $w'' = C_i \varkappa_i$

(2) Clamped-Clamped Column

The boundary conditions are

$$w(0) = w(\ell) = 0$$

$$w'(0) = w'(\ell) = 0$$

This results in two different types of modes. Modes which are symmetrical about the mid-length of the column and modes wh'^h are anti-symmetrical.

For symmetrical modes

$$w_{is} = a_i \left(1 - \cos \frac{2\,i\pi x}{\ell}\right) \tag{3b}$$

$$\frac{F_i}{EI} = \lambda_i = \frac{4\, i^2 \pi^2}{\ell^2} \tag{4b}$$

$$\chi_{is} = \cos \frac{2\, i\, \pi\, x}{\ell} \tag{5b}$$

$$C_{is} = \frac{\int_0^{\ell} w'' \chi_i \, dx}{\int_0^{\ell} \chi_i^{\,2} \, dx} = \frac{2}{\ell} \int_0^{\ell} w'' \cos \frac{2\, i\, \pi\, x}{\ell} \, dx \tag{6b}$$

<u>For anti-symmetrical modes</u>

$$w_i = a_i \left(\frac{2\mu_i \frac{x}{\ell} - \sin 2\mu_i \frac{x}{\ell}}{2\mu_i - \sin 2\mu_i} - \frac{1 - \cos 2\mu_i \frac{x}{\ell}}{1 - \cos 2\mu_i} \right)$$

$$\chi_i = \frac{\sin 2\mu_i \frac{x}{\ell}}{2\mu_i - \sin 2\mu_i} - \frac{\cos 2\mu_i \frac{x}{\ell}}{1 - \cos 2\mu_i} \qquad \text{where } \mu_i = \tan \mu_i$$

An alternate form, employing the mid-length of the column as an origin, results in a simpler result which is identical to the joining of two simple-clamped columns.

$$w_{ia} = a_i \left(\frac{\sin \frac{\mu_i}{2} \frac{x}{\ell}}{\sin \frac{\mu_i}{2}} - \frac{x}{2\ell} \right) \tag{3c}$$

$$\frac{F_{ia}}{EI} = \lambda_i = \left(\frac{\mu_1}{\ell/2} \right)^2 = \frac{4\mu_1^{\,2}}{\ell^2} \tag{4c}$$

where $\tan \mu_i = \mu_i$

and $\mu_1 = 1.43 \quad \mu_n \rightarrow \left(\frac{2n+1}{2} \right) \pi$

$$\chi_{ia} = \sin \frac{\mu_i}{2} \frac{x}{\ell} \tag{5c}$$

$$C_{ia} = \frac{\int_0^{\ell/2} w'' \chi_i \, dx}{\int_0^{\ell/2} \chi_i^{\,2} \, dx} = \frac{\ell}{\ell \left(\frac{1}{4} - \frac{\cos \mu_i}{\mu_i} \right)} \int_0^{\ell/2} w'' \sin \frac{\mu_i}{2} \frac{x}{\ell} \, dx \tag{6c}$$

2.2.3 (Cont'd)

(3) Simple Clamped Column

The boundary conditions are

$$w(0) = w''(0) = 0$$

$$w(\ell) = w'(\ell) = 0$$

$$w_i = a_i \left(\frac{\sin \mu_i \frac{x}{\ell}}{\sin \mu_i} - \frac{x}{\ell} \right) \tag{3d}$$

where $\tan \mu_i = \mu_i$

$$\frac{F_i}{EI} = \lambda_i = \frac{\mu_i^2}{\ell^2} \tag{4d}$$

$$\chi_i = \sin \mu_i \frac{x}{\ell} \tag{5d}$$

$$C_{ia} = \frac{\int_0^\ell w'' \chi_i \, dx}{\int_0^\ell \chi_i^2 \, dx} = \frac{1}{\ell \left(\frac{1}{2} - \frac{\cos 2\mu_i}{\mu_i} \right)} \int_0^\ell w'' \sin \mu_i \frac{x}{\ell} \, dx \tag{6d}$$

The deformation modes and buckling loads are required in the determination of the end load and deflection of a restrained column as indicated in Subsection 2.3. If the boundary conditions or stiffness destribution do not conform to the case summarized above, then the buckling loads and modes must be determined for the column considered. Special cases may be found in various text and recourse must be taken to approximate solutions when the column becomes more involved.

The method of solution for a column with a linear material, propo:ed in this report, is quite general and can handle the more complex configurations provided the initial deflection can be described by characteristic eigenvectors with known eigenvalues.

2.2.4 Compatibility Equation

The axially unrestrained column (Figure 2.1-1b) will deform when subjected to lateral loads and temperature. This will cause an axial motion of the ends of the column of Δ_{oo}.

$$\Delta_{oo} = \ell \alpha T - \Delta_o \tag{1a}$$

where $\alpha T = \epsilon_T$ is the unrestrained axial strain due to temperature. If the strains are not uniform then

$$\alpha T = \frac{1}{\ell} \int_0^\ell \frac{\int \alpha T dA}{\int dA} \, dx \tag{1b}$$

2.2.4 (Cont'd)

Δ_o = axial shortening of the column due to the lateral load and temperature gradients through the cross sections

$$\Delta_o = \frac{1}{2} \int_o^{\ell} (w_T' + w_q')^2 \, dx \tag{1c}$$

The application of the axial load causes the column to shorten due to the axial strain $\frac{F\ell}{AE}$ and additional axial shortening $(\Delta - \Delta_o)$. The final movement of the ends must be equal to the deformation of the axial spring F/k.

$$\therefore \ell\alpha T - \Delta_o - \frac{F\ell}{AE} - (\Delta - \Delta_o) = \frac{F}{k} \tag{2a}$$

Dividing by the quantity $\ell\epsilon_1$ results in

$$\frac{\alpha T - \frac{\Delta_o}{\ell}}{\epsilon_1} - \frac{F}{AE\,\epsilon_1} - \frac{\frac{\Delta}{\ell} - \frac{\Delta_o}{\ell}}{\epsilon_1} - \frac{F}{k\ell\,\epsilon_1} = 0 \tag{2b}$$

$$\text{where } \epsilon_1 = \frac{F_1}{AE} = \frac{\lambda_1 EI}{AE} = \lambda_1 \rho^2 \tag{2c}$$

Noting that

$$\frac{F}{AE\,\epsilon_1} = \frac{\sigma A}{AE\epsilon_1} = \frac{E\epsilon A}{AE\,\epsilon_1} = \frac{\epsilon}{\epsilon_1} = \eta_1 \tag{3a}$$

and

$$\frac{F}{k\ell\,\epsilon_1} = \frac{E\epsilon A}{k\ell\epsilon_1} = \frac{EA}{k\ell} \quad \eta_1 \tag{3b}$$

and letting

$$\frac{\alpha T - \Delta_o/\ell}{\epsilon_1} = b \tag{4}$$

and evaluating the axial shortening

$$\Delta_o = \frac{1}{2} \int_o^{\ell} (w_T' + w_q')^2 dx = \frac{1}{2} \int_o^{\ell} (w_o')^2 dx = \frac{1}{2} \int_o^{\ell} (\Sigma w_{1o}')^2 dx \tag{5a}$$

but because of the orthogonality of the characteristic slopes (Eq. (3) of Paragraph 2.2.1) we obtain

$$\Delta_o = \frac{1}{2} \int_o^{\ell} \Sigma (w_{1o}')^2 \, dx = \frac{1}{2} \, \Sigma \int_o^{\ell} (w_{1o}')^2 \, dx \tag{5b}$$

2.2.4 (Cont'd)

and

$$\Delta - \Delta_o = \frac{1}{2}\int_o^{\ell} \left[(w')^2 - (w_o')^2\right] dx = \frac{1}{2}\int_o^{\ell} \Sigma (w_{io}')^2 \left[\left(\frac{1}{1-\eta_1}\right)^2 - 1\right] dx \tag{5c}$$

$$= \frac{1}{2}\sum\left[\left(\frac{1}{1-\eta_i}\right)^2 - 1\right]\int_o^{\ell} (w_{io}')^2\, dx$$

letting

$$\frac{\Delta_i}{\ell\epsilon_1} = \frac{\frac{1}{2}\int_o^{\ell} (w_{io}')^2 dx}{\ell\epsilon_1} = d_i \tag{6a}$$

and

$$\left(\frac{1}{1-\eta_i}\right)^2 - 1 = \varphi_i \tag{6b}$$

we obtain

$$\frac{\Delta_o}{\ell\epsilon_1} = \Sigma d_i \tag{6c}$$

and

$$\frac{\Delta - \Delta_o}{\ell\epsilon_1} = \Sigma d_i \varphi_i \tag{6d}$$

Substituting Eqs. (3a), (3b), (4), and (6 i) into Eq. (2b) results in

$$b - \eta_1 - \Sigma d_i \varphi_i \quad \frac{EA}{k\ell} \quad \eta_1 = 0 \tag{7}$$

The above equation is quite difficult to solve, but the solution can be simplified if it is noted that the expression $d_i\varphi_i$ denotes the increase in axial deformation due to the growth of the i^{th} mode of deformation. The first mode is magnified to a much greater degree than the higher modes when the axial load is compression. In fact the first mode becomes predominant as the axial load approaches the first buckling load. The approximate method utilizes this fact in approximating the value of $\Sigma d_i\varphi_i$ by expanding $d_i\varphi_i$ (for i > 1) as a power series and only employing the most significant term and by approximating the infinite series by a finite series. This approximation method is not recommended for tension loads, since the approximation for φ_i and the infinite series may be incorrect.

2.2.4 (Cont'd)

Noting that

$$\varphi_i = \left(\frac{1}{1-\eta_i}\right)^2 - 1 = 1 + 2\eta_i + 3\eta_i^2 + \ldots - 1 \sim 2\eta_i \tag{8a}$$

and that $1 > \eta_1 > \eta_i \quad (i \geq 2)$ (8b)

$$\therefore \sum_{i=1}^{\infty} d_i \varphi_i = d_1 \varphi_1 + \sum_{i=2}^{\infty} d_i \varphi_i \text{ is approximately } d_1 \varphi_1 + 2 \sum_{i=2}^{n} \eta_i d_i$$

(8c)

where n is a sufficiently large integer.

Equation (7) can thus be approximated by

$$b - d_1 \varphi_1 - \left(1 + \frac{EA}{k} + 2 \sum_{i=2}^{n} \frac{\eta_i}{\eta_1} d_i\right) \eta_1 = 0 \tag{9a}$$

Letting

$$\Phi = 1 + \frac{EA}{k\ell} + 2 \sum_{i=2}^{n} \frac{\eta_i}{\eta_1} d_i \tag{9b}$$

we obtain

$$\frac{b}{\Phi} - \frac{d_1}{\Phi} \varphi_1 - \eta_1 = 0 \tag{9c}$$

or

$$\bar{b} - \bar{d}_1 \varphi_1 - \eta_1 = 0 \tag{9d}$$

where

$$\bar{b} = \frac{b}{\Phi} \tag{9e}$$

and

$$\bar{d}_1 = \frac{d_1}{\Phi} \tag{9f}$$

The value of the axial strain parameter (η_1) can be determined from a graphical plot (Figure 2.2.4-1 and -2) of the variation of $\bar{b}$ with η_1 for various $\bar{d}_1$. This value of η_1 can then

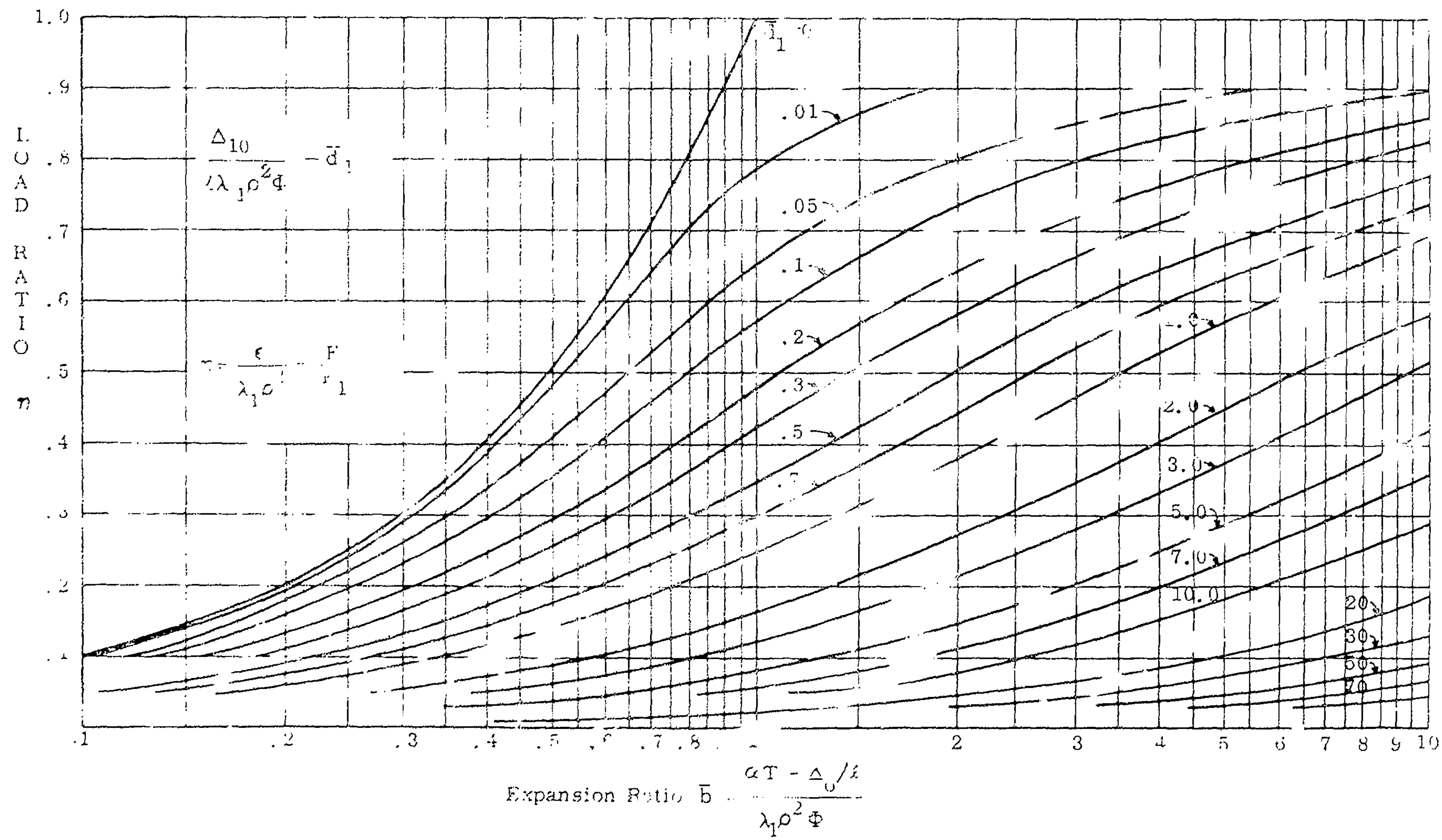


FIGURE 2.2.4-1 AXIAL LOAD IN A RESTRAINED COLUMN

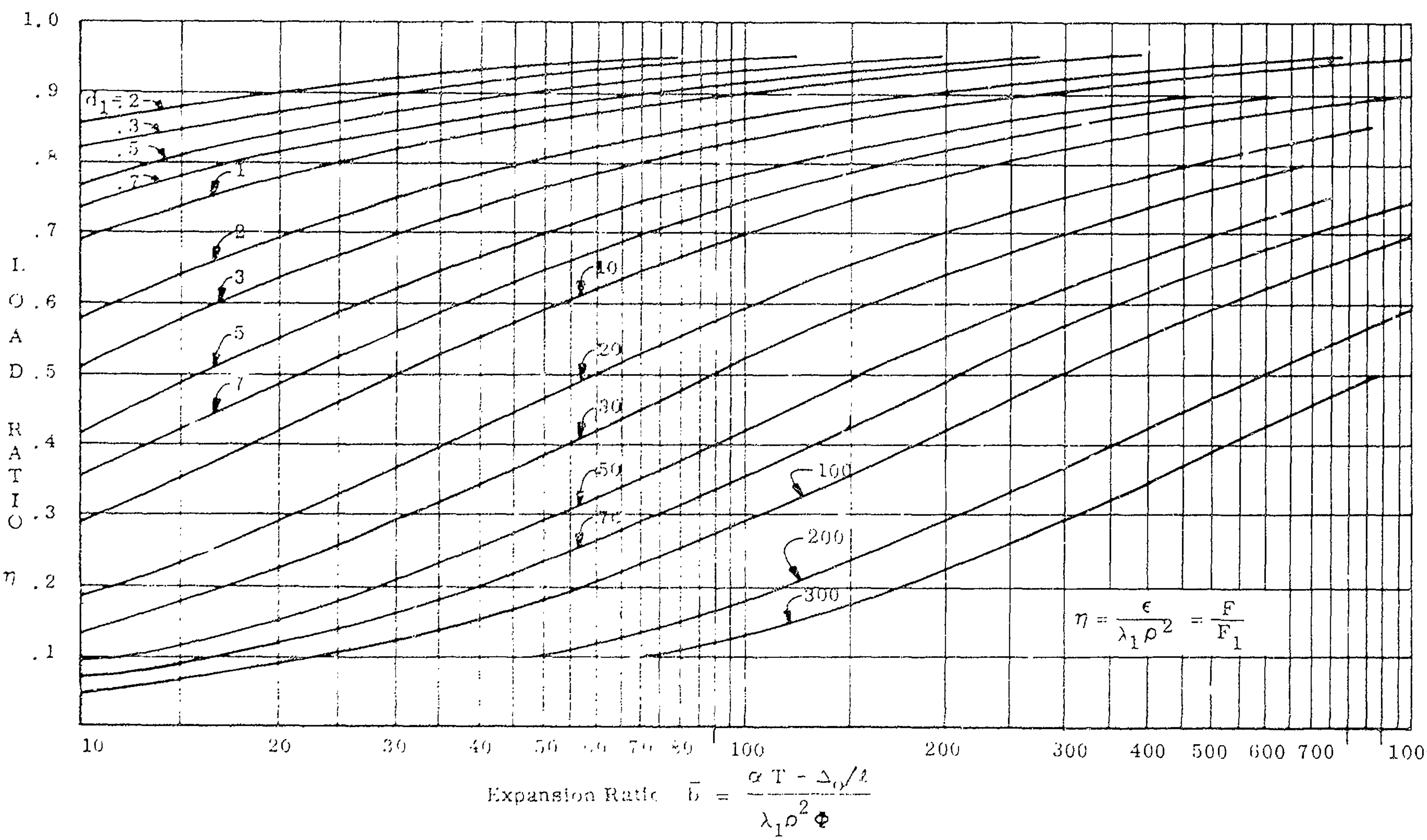


FIGURE 2.2.4-2 AXIAL LOAD IN A RESTRAINED COLUMN

2.2.4 (Cont'd)

be employed to obtain the axial load acting on the column and the deformations of the column. It should be noted that the approximate method results in an upper bound on the axial load since it ignores a small part of the change of axial motion due to the higher modes.

2.3 PROCEDURE

The information and technique needed to solve the problem are enumerated in the following sections.

2.3.1 Determination of Nondimensional Parameters

By the definition Eq. (6a) of Paragraph 2.2.4:

$$d_i = \frac{\frac{1}{2}\int_0^{\ell} (w'_{io})^2\, dx}{\ell\, \epsilon_1} = \frac{\Delta_i}{\ell\, \lambda_1\, \rho^2}$$

Equation (9.1.2 - 3c) of Reference 2-2 indicates that

$$\lambda_i = \frac{F_i}{EI} = \frac{\int_0^{\ell} \varphi (w''_i)^2\, dx}{\int_0^{\ell} (w'_i)^2\, dx} = \frac{\int_0^{\ell} \varphi\, C_i^2\, x_i^2\, dx}{2\, \Delta_i} \tag{1a}$$

$$\therefore\ \Delta_i = \frac{C_i^2 \int_0^{\ell} \varphi\, x_i^2\, dx}{2 \lambda_i} \tag{1b}$$

and

$$d_i = \frac{C_i^2 \int_0^{\ell} \varphi\, x_i^2\, dx}{2\, \ell\, \lambda_1 \lambda_i \rho^2} \tag{2a}$$

Noting that

$$\frac{\eta_i}{\eta_1} \quad \frac{\epsilon/\epsilon_i}{\epsilon/\epsilon_1} = \frac{\epsilon_1}{\epsilon_i} = \frac{\lambda_1\, \rho^2}{\lambda_i\, \rho^2} = \frac{\lambda_1}{\lambda_i} \tag{3}$$

$$\therefore\ 2\frac{\eta_i}{\eta_1}\, d_i = \frac{C_i^2 \int_0^{\ell} \varphi\, x_i^2\, dx}{\ell\, \lambda_i^2\, \rho^2} \tag{4a}$$

d_i and $\frac{\eta_i d_i}{\eta_1}$ will be evaluated for the chosen boundary conditions and for constant EI ($\varphi = 1$) utilizing Eqs. (5) and (6) of Paragraph 2.2.3.

(1) Simple-Simple Column

$$d_i = \frac{C_i^{\,2} \qquad \ell/2}{2\ell\left(\frac{\pi}{\ell}\right)^2\left(\frac{i\pi}{\ell}\right)^2 \rho^2} = \frac{\ell^4}{4\pi^4\rho^2}\left(\frac{C_i^{\,2}}{i^2}\right) \tag{2b}$$

$$2\,\frac{d_i\eta_i}{\eta_1} = \frac{C_i^{\,2}\ \ell/2}{\ell\left(\frac{i\pi}{\ell}\right)^4 \rho^2} = \frac{\ell^4}{2\pi^4\rho^2}\left(\frac{C_i^{\,2}}{i^4}\right) \tag{4b}$$

(2) Clamped-Clamped Column

Symmetrical

$$d_{is} = \frac{C_{is}^{\,2} \qquad \ell/2}{2\ell\rho^2\left(\frac{2\pi}{\ell}\right)^2\left(\frac{2i\pi}{\ell}\right)^2} = \frac{\ell^4}{64\pi^4\rho^2}\left(\frac{C_{is}^{\,2}}{i^2}\right) \tag{2c}$$

$$2\,\frac{d_{is}\eta_{is}}{\eta_1} = \frac{C_{is}^{\,2} \qquad \ell/2}{\ell\rho^2\left(\frac{2i\pi}{\ell}\right)^4} = \frac{\ell^4}{32\pi^4\rho^2}\left(\frac{C_{is}^{\,2}}{i^4}\right) \tag{4c}$$

Antisymmetrical

$$d_{ia} = \frac{C_{ia}^2\,\ell\left(\frac{1}{2} - \frac{2\cos\mu_i}{\mu_i}\right)}{2\ell\rho^2\left(\frac{2\pi}{\ell}\right)^2\left(\frac{2\mu_i}{\ell}\right)^2} = \frac{\ell^4\,C_{ia}^{\,2}\left(\frac{1}{2} - \frac{2\cos\mu_i}{\mu_i}\right)}{32\pi^2\,\rho^2\,\mu_i^{\,2}} \tag{2d}$$

$$2\,\frac{d_{ia}\eta_{ia}}{\eta_1} = \frac{C_{ia}^{\,2}\,\ell\left(\frac{1}{2} - \frac{2\cos\mu_i}{\mu_i}\right)}{\ell\rho^2\left(\frac{2\mu_i}{\ell}\right)^4} = \frac{\ell^4\,C_{ia}^{\,2}\left(\frac{1}{2} - \frac{2\cos\mu_i}{\mu_i}\right)}{16\,\rho^2\,\mu_i^{\,4}} \tag{4d}$$

2.3.1 (Cont'd)

(3) Clamped-Simple Column

$$d_i = \frac{C_i^2\, \ell \left(\frac{1}{2} - \frac{\cos \mu_i}{\mu_i}\right)}{2\ell\rho^2 \left(\frac{1.43\pi}{\ell}\right)^2 \left(\frac{\mu_i}{\ell}\right)^2} = \frac{\ell^4\, C_i^2 \left(\frac{1}{2} - \frac{\cos 2\mu_i}{\mu_i}\right)}{4.1\,\pi^2 \rho^2 \mu_i^2} \tag{2e}$$

$$2\,\frac{d_i\,\eta_i}{\eta_i} = \frac{C_i^2\, \ell \left(\frac{1}{2} - \frac{\cos 2\mu_i}{\mu_i}\right)}{\ell\rho^2 \left(\frac{\mu_i}{\ell}\right)^2} = \frac{\ell^4}{\rho^2}\; \frac{C_i \left(\frac{1}{2} - \frac{\cos \mu_i}{\mu_i}\right)}{\mu_i^4} \tag{4e}$$

(4) Summary

Equation (9a) of Paragraph 2.2.4 can then be summarized for columns of constant EI as follows:

Simple-Simple

$$\frac{\alpha T - \Delta_o/\ell}{\frac{\pi^2}{\ell^2}\rho^2} - \left(\frac{\ell^4\, C_1^2}{4\pi^4 \rho^2}\right)\varphi_1 - \left(1 + \frac{EA}{k\ell} + \frac{\ell^4}{2\pi^4\rho^2} \sum_{i=2}^{n} \frac{C_i^2}{i^2}\right)\eta_1 = 0 \tag{5a}$$

Clamped-Clamped Column

$$\frac{\alpha T - \Delta_o/\ell}{\frac{4\pi^2}{\ell^2}\rho^2} - \left(\frac{\ell^4\, C_1^2}{64\pi^4 \rho^2}\right)\varphi_1$$

$$- \left[1 + \frac{EA}{k\ell} + \frac{\ell^4}{32\pi^4\rho^2} \sum_{i=1}^{n} \frac{C_{is}^2}{i^4} + \frac{\ell^4}{16\rho^2} \sum_{i=1}^{n} \frac{C_i^2 \left(\frac{1}{2} - \frac{\cos 2\mu_i}{\mu_i}\right)}{\mu_i^4}\right] = 0 \tag{5b}$$

Simple-Clamped Column

$$\frac{\alpha T - \frac{\Delta_o}{\ell}}{\frac{2.05\pi^2}{\ell^2}\rho^2} - \left(\frac{.07081\,\ell^4\, C_1^2}{\pi^4 \rho^2}\right)\varphi_1 - \left[1 + \frac{EA}{k\ell} + \frac{\ell^4}{\rho^4} \sum_{i=2}^{n} \frac{C_i^2 \left(\frac{1}{2} - \frac{\cos 2\mu_i}{\mu_i}\right)}{\mu_i^4}\right] = 0 \tag{5c}$$

2.3.2 Computational Procedure

The following computational procedure is recommended to obtain the approximate solution for the axial load and lateral deflection of a restrained column.

(1) Determine the axial expansion of the column due to temperature and the lateral load, assuming, at this step, that the restraint against actual expansicn is removed.

$$\ell \alpha T - \Delta_o = \int_o^{\ell} \epsilon_T dx - \int_o^{\ell} (w_o')^2 \, dx \tag{1}$$

where $w_o = w_q + w_T$

w_q = lateral deflection due to lateral loads (usually obtained from reference texts)

w_T = lateral deflection due to thermal gradients (method of determining w_T indicated in Section 4 of Reference 2-2).

ϵ_T = axial expansion due to temperature (method of determining ϵ_T indicated in Section 4 of Reference 2-2).

(2) Calculate the critical axial strain from Eq. (2c) of Paragraph 2.2.4)

$$\epsilon_1 = \lambda_1 \frac{I}{A} = \lambda_1 \rho^2$$

$$\left(\text{e.g. } \epsilon_1 = \frac{\pi^2}{\ell^2} \rho^2 \text{ for simple-simple, } \varphi = 1\right)$$

(3) Expand the initial curvature ($w_o'' = \Sigma C_i x_i$), due to the lateral load and temperature, in terms of the characteristic curvatures of the column. A sufficient number of terms of the series should be taken to ensure accuracy. The coefficients of the characteristic curvatures are obtained by the general equation

$$C_i = \frac{\int_o^{\ell} \varphi w_o'' x_i \, dx}{\int_o^{\ell} \varphi x_i^2 \, dx} \tag{2}$$

Formulas for constant EI ($\varphi = 1$) are presented in Eqs. (6a), (6b), (6c), and (6d) of Paragraph 2.2.3. Tables to evaluate the integrals of Eqs. (6a) and (6b) of Paragraph 2.2.3 are presented in Tables 2.3.3.1.2-1 and -2.

(4) Evaluate the pertinent parameters

(a) $$d_i = \frac{\Delta_{io}}{\ell \epsilon_1} = \frac{C_i^2 \int \varphi x_i^2 \, dx}{2 \rho^2 \lambda_1 \lambda_i \ell}$$ (Reference Eq. (2a) of Paragraph 2.3.1)

2.3.2 (Cont'd)

Appropriate formulas for d_i are presented for columns of constant EI and for the chosen boundary conditions in Paragraph 2.3.1.

(e.g. $d_i = \frac{\ell^4}{4\pi^4 \rho^2} \frac{C_i^2}{i^2}$ for simple-simple column).

(b) $$\Phi = 1 + \frac{EA}{k\ell} + 2 \sum_{i=2}^{n} \frac{\eta_i}{\eta_1} d_i$$ (Reference Eq. (9b) of Paragraph 2.2.4)

Values of Φ are indicated in Eq. (5) of Paragraph 2.3.1 for constant EI.

(e.g. $\Phi = 1 + \frac{EA}{k\ell} + \frac{\ell^4}{2\pi^4 \rho^2} \sum_{i=2}^{n} \frac{C_i^2}{i^4}$ for simple-simple column)

(c) $$\overline{d}_1 = \frac{d_1}{\Phi}$$ (Reference Eq. (9f) of Paragraph 2.2.4)

(d) $$\overline{b} = \frac{\alpha T - \Delta_{o/\ell}}{\epsilon_1 \Phi} = \frac{\alpha T - \Delta_{o/\ell}}{\lambda_1 \rho^2 \Phi}$$ (Reference Eq. (9e) of Paragraph 2.2.4)

(5) Enter Figure 2.2.4-1 or -2 with the appropriate values of $\overline{b}$ and $\overline{d}_1$ and determine η_1.

(6) The axial load is then determined from Eq. (3a) of Paragraph 2.2.4.

$$F = \sigma A = E \frac{\epsilon}{\epsilon_1} \epsilon_1 A \quad EA \lambda_1 \rho^2 \eta_1 \tag{3}$$

(7) The lateral deflection of the column could likewise be determined as

$$w = \sum \frac{w_{oi}}{1 - \eta_i} \tag{4a}$$

where the value of $\eta_i = r_1 \frac{\lambda_1}{\lambda_i}$ (4b)

and the value of $\frac{1}{1-\eta_i}$ can be calculated or determined with the aid of Figure 2.2.1-1.

(e.g. $w = \frac{2}{\pi^2} \sum \left(\frac{\ell^2 C_1}{2}\right) \frac{\sin (i\pi x/\ell)}{i^2 - \eta_1}$ for pinned end column).

2.3.2 (Cont'd)

(8) A slightly better approximation to the value of η_1 can be obtained by employing

$$\bar{b} = \frac{\dfrac{\alpha T - \Delta_{o/\ell}}{\lambda_1 \rho^2} - \left(\dfrac{\Delta_o}{\ell \lambda_1 \rho^2} - \sum_{i=1}^{n} d_i\right)}{\Phi} \tag{5}$$

which corrects for the error in approximating the initial shortening by a finite series. The additional shortening of the higher modes is still approximated by the first term of the series in order to simplify the solution of the compatibility equation.

(9) The graphs can also be employed to determine the approximate average temperature rise (with no cross-sectional gradient) required to produce a maximum permissible lateral deflection. The permissible ratio of maximum to initial lateral deflection $\left(\frac{w_{max}}{w_o}\right)$ can be employed with Figure 2.2.1-1 to estimate a value of η_1 which can be utilized with $\bar{d}_1$ in Figures 2.2.4 to determine a value of $\bar{b}$ which could then be employed to calculate αT. (If the higher modes of the initial deflection are significant, then they must be included as indicated in Eq. (4a)). The initial eccentricity will permit the calculation of Φ and $\bar{d}_1$. Assuming a value of η_1 or of αT will permit the determination of the other from Figure 2.2.4. The value of η_1 could then be used to determine w which could be plotted against αT; αT could also be plotted against the axial load by employing Eq. (3a) of Paragra ' 2.2.4. A typical plot is shown in Figure 2.3.2-1.

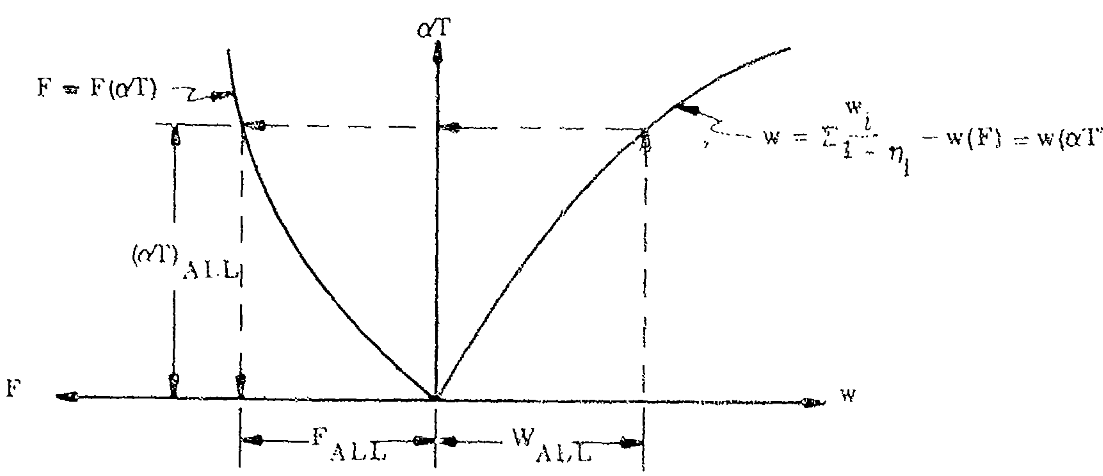


FIGURE 2.3.2-1 AXIAL LOAD AND LATERAL DEFLECTION VS AVERAGE TEMPERATURE RISE

2.3.3 Initial Deformations

The initial deformations before the end load is applied must be determined to a fair degree of accuracy. Two methods are presented herein. The first procedure assumes that an analytical expression for the initial lateral deflections is available as a polynomial, while the second method assumes that the lateral deflection is known only at a finite number of points (e.g., determined experimentally or by computations).

2.3.3.1. Polynomial Representation

The lateral deformation of a beam can be determined by integrating the equilibrium equation (Eq. (3) of Paragraph 2.2.2) with $\lambda = 0$ and employing the given boundary conditions. Solutions for lateral loading are available in literature for the type of boundary conditions considered (e.g., $w_q = \frac{q\ell^4}{24\,EI}\left[\left(\frac{x}{\ell}\right) - 2\left(\frac{x}{\ell}\right)^3 + \left(\frac{x}{\ell}\right)^4\right]$ for a simple-simple beam with uniform lateral load). The slopes and curvatures can be obtained by differentiating these polynomial expressions. The lateral deflection due to thermal gradients is not as readily available but can be derived quite simply by utilizing the equations of Section 4 of Reference 2-2. The technique is illustrated for the simple-simple and clamped-clamped beams.

2.3.3.1.1 Lateral Deformation of Beams by Temperature Gradients

Let the thermal gradient through the depth of the beam be expressed as a polynomial in the spanwise dimension,

e.g.

$$\frac{\alpha T_o - \alpha T_i}{h} = -\frac{\Delta \alpha T}{h} = \frac{1}{\ell^2}\,\Sigma\, m_j \left(\frac{x}{\ell}\right)^j = \frac{1}{\ell^2}\,\Sigma m_j\, \xi^j \tag{1}$$

where T_i and T_o are the temperatures on the positive and negative side of the column with a linear gradient (see Figure 2.1-1).

If the structure is statically determinate, as in a simple-simple beam, then the thermal gradient represents the total curvature (w''_T) since no redundant forces are produced by the temperature. The slope and deflection can then be obtained by integrating this curvature and employing the given boundary conditions.

$$\therefore\; w = \frac{1}{\ell^2}\int_o^x \int_o^{x_o} \Sigma\, m_j \left(\frac{x}{\ell}\right)^j dx\, dx = \int_o^{\xi}\int_o^{\xi_o} \Sigma\, m_j\, \xi^j\, d\xi\, d\xi$$

$$w = \sum \frac{m_j\, \xi^{j+2}}{(j+1)\,(j+2)} + c_1\,\xi + c_2 \tag{2}$$

For simple supports $w(o) = w(\ell) = 0$

$$\therefore\; w = \sum \frac{m_j}{(j+1)\,(j+2)}\left(\xi^{j+2} - \xi\right) \tag{3a}$$

$$\&\; w' = \frac{1}{\ell}\sum \frac{m_j}{(j+1)\,(j+2)}\left[(j+2)\,\xi^{j+1} - 1\right] \tag{3b}$$

2.3.3.1.1 (Cont'd)

If the structure is statically indeterminate, as in the clamped-clamped beam, then the curvature is affected by the curvature caused by the redundant loads. Equations (4.2.2.5 - 7 and -8) of Reference 2-2 can be employed to determine the deformation of the clamped beams where subjected to a thermal gradient. The thermal gradient $\frac{\Delta \alpha T}{h} = -m_j \xi^j/\ell^2$ induces redundant loads P_o and M_o and the following total deformations result:

$$w''_T = \frac{1}{\ell^2} \sum m_j \left[\xi^j - \frac{6j\xi}{(j+1)(j+2)} - \frac{2(1-j)}{(j+1)(j+2)}\right] \tag{4a}$$

$$w'_T = \frac{1}{\ell} \sum m_j \left[\frac{\xi^{j+1}}{j+1} - \frac{3j\xi^2}{(j+1)(j+2)} - \frac{2(1-j)\xi}{(j+1)(j+2)}\right] \tag{4b}$$

$$w_T = \sum \frac{m_j}{(j+1)(j+2)} \left[\xi^{j+2} - j\xi^3 - (1-j)\xi^2\right] \tag{4c}$$

2.3.3.1.2. Expansion in Characteristic Curvatures

The polynomial definition of curvature can be converted to a eigenvector expansion by means of Eqs. (2a) of Paragraph 2.2.2 and (2) of Paragraph 2.3.2.

$$w''_T + w''_q = w''_o = \Sigma C_i x_i \quad \text{(Refer to Eq. (2a) of Paragraph 2.2.2)}$$

$$C_i = \frac{\int_0^\ell \varphi w''_o x_i \, dx}{\int_0^\ell \varphi x_i^2 \, dx} \quad \text{(Refer to Eq. (2) of Paragraph 2.3.2)}$$

For the simple-simple column with constant EI, this results in the simple Fourier sine expansion of the initial curvature.

$$C_i = \frac{2}{\ell}\int_0^\ell w''_o \sin \frac{i\pi x}{\ell} dx = \frac{2}{\ell^2} \Sigma m_j \int_0^1 \xi^j \sin i\pi\xi \, d\xi \tag{1a}$$

where $w''_o = \frac{1}{\ell^2} \Sigma m_j \xi^j$

The clamped-clamped column with constant EI and symmetrical loading results in a Fourier cosine expansion.

$$C_{is} = \frac{2}{\ell}\int_0^\ell w''_{os} \cos \frac{2i\pi x}{\ell} dx = \frac{2}{\ell^2} \Sigma m_j \int_0^1 \xi^j \cos 2i\pi\xi \, d\xi \tag{1b}$$

The curvature coefficients for the clamped-simple and the clamped-clamped columns with anti-symmetrical load must be similarly evaluated.

2.3.3.1.2 (Cont'd)

Tables 2.3.3.1.2-1 and -2 present the values of the integrals for the simple-simple and the symmetrical clamped-clamped columns.

TABLE 2.3.3.1.2-1 FOURIER EXPANSION OF MONOMIAL FOR SIMPLE-SIMPLE COLUMN

S(j, i)

j \ i	1	2	3	4	5	6
0	.6366	0	.2122	0	.12732	0
1	.3183	-.1591	.1061	-.07958	.06366	-.05305
2	.1893	-.1591	.1013	-.07958	.06262	-.05303
3	.1248	-.1350	.09894	-.07655	.06211	-.05215
4	.08814	-.1108	.09241	-.07353	.06061	-.05125
5	.06541	-.09078	.08383	-.06988	.05862	-.05011
6	.05038	-.07497	.07489	-.06560	.05629	-.04872
7	.03995	-.06258	.06647	-.06099	.05368	-.04712
8	.03243	-.05280	.05889	-.05631	.05088	-.04537
9	.02683	-.04503	.05223	-.05176	.04799	-.04350
10	.02256	-.03877	.04644	-.04748	.04510	-.04155

$$w'' = \Sigma C_i \sin \frac{i\pi x}{\ell} = \frac{1}{\ell^2} \Sigma m_j \left(\frac{x}{\ell}\right)^j = \frac{1}{\ell^2} \Sigma m_j \xi^j$$

$$C_i = \frac{2}{\ell^2} \Sigma m_j \int_0^1 \xi^j \sin i\pi\xi \, d\xi = \frac{2}{\ell^2} \sum_j \sum_i m_j S(j, i) \qquad (2a)$$

$$S(j, i) = \int_0^1 \xi^j \sin i\pi\xi \, d\xi$$

$$S(j, i) = \frac{\left[1 + (-1)^j\right] (-1)^{j/2} j!}{2 (i\pi)^{j+1}} \quad (-1)^i \sum_{n=0,2,4}^{j+\frac{1}{2}\left[(-1)^j - 1\right]} \frac{(-1)^{\frac{n}{2}+1}}{(i\pi)^{n+1}} \frac{j!}{(j-n)!} \qquad (2b)$$

2.3.3.1.2 (Cont'd)

TABLE 2.3.3.1.2-2 FOURIER EXPANSION OF MONOMIAL FOR CLAMPED-CLAMPED COLUMN

C (j, i)

j \ i	1	2	3	4	5	6
1	0	0	0	0	0	0
2	.05066	.01267	.00563	.00317	.00203	.00141
3	.07599	.01900	.00844	.00475	.00304	.00211
4	.08592	.02437	.01107	.00627	.00403	.00280
5	.08815	.02926	.01360	.00777	.00500	.00349
6	.08669	.03337	.01595	.00920	.00596	.00416
7	.08353	.03655	.01809	.01057	.00688	.00482
8	.07967	.03883	.02000	.01185	.00777	.00546
9	.07563	.04033	.02166	.01304	.00862	.00609
10	.07167	.04120	.02308	.01414	.00942	.00669

$$w'' = \Sigma C_i \cos \frac{2\pi i x}{\ell} = \frac{1}{\ell^2} \Sigma m_j \left(\frac{x}{\ell}\right)^j = \frac{1}{\ell^2} \Sigma m_j \xi^j$$

$$C_i = \frac{2}{\ell^2} \Sigma m_j \int_0^1 \xi^j \cos 2 i \pi \xi \, d\xi = \frac{2}{\ell^2} \sum_j \sum_i m_j \, (C(j, i)) \qquad (3a)$$

$$C(j, i) = \int_0^1 \xi^j \cos 2 i \pi \xi \, d\xi$$

$$C(j, i) = \frac{\left[1 + (-1)^j\right] (-1)^{j/2} \, j!}{2 \, (2 i \pi)^{j+1}} + \sum_{n=1,3,5}^{j-\frac{1}{2}\left[(-1)^j + 1\right]} \frac{j!}{(2 i \pi)^{i+n} (j-n)!} \qquad (3b)$$

2.3.3.2 Discrete Lateral Deformation

In some instances the lateral deflection is not known as a continuous function, but is determined analytically (see Paragraph 4.2.1 of Reference 2-2) or experimentally at a discrete number of points. The deformation of "n" discrete points can be employed to obtain an approximating expansion of "n" characteristic deflection shapes. The amplitude of the "n" characteristic deflections are determined by matching the displacements at the known points. The technique is illustrated for a simple-simple column with known deflections at the 1/6 points (n = 5).

$$w\,(\xi_j) = w\left(\frac{x_j}{l}\right) = w_j = \sum_{i=1}^{5} a_i \sin\frac{i\pi x}{l} \qquad \text{(1a)}$$

The symmetry of the odd characteristic deflections and the anti-symmetry of the even characteristics can be employed to reduce the order of the simultaneous equations necessary to solve for the amplitudes (a_i).

$$\left.\begin{aligned}
\therefore \quad \frac{w_1 + w_5}{2} &= a_1 \sin\frac{\pi}{6} + a_3 \sin\frac{3\pi}{6} + a_5 \sin\frac{5\pi}{6} \\
\frac{w_2 + w_4}{2} &= a_1 \sin\frac{2\pi}{6} + a_3 \sin\frac{6\pi}{6} + a_5 \sin\frac{10\pi}{6} \\
w_3 &= a_1 \sin\frac{3\pi}{6} + a_3 \sin\frac{9\pi}{6} + a_5 \sin\frac{15\pi}{6} \\
\frac{w_1 - w_5}{2} &= a_2 \sin\frac{2\pi}{6} + a_4 \sin\frac{4\pi}{6} \\
\frac{w_2 - w_4}{2} &= a_2 \sin\frac{4\pi}{6} + a_4 \sin\frac{8\pi}{6}
\end{aligned}\right\} \qquad \text{(1}$$

The solution is

$$\left.\begin{aligned}
\begin{pmatrix} a_1 \\ a_3 \\ a_5 \end{pmatrix} &= \begin{pmatrix} .333 & .577 & .333 \\ .667 & 0 & -.333 \\ .333 & -.577 & .333 \end{pmatrix} \begin{pmatrix} \frac{w_1 + w_5}{2} \\ \frac{w_2 + w_4}{2} \\ w_3 \end{pmatrix} \\
a_2 &= \frac{1}{3.464} \left(w_1 + w_2 - w_4 - w_5\right) \\
a_4 &= \frac{1}{3.464} \left(w_1 - w_2 + w_4 - w_5\right)
\end{aligned}\right\} \qquad \text{(1c)}$$

It should be noted that $C_i = -\dfrac{i^2\pi^2}{\ell^2} a_i$ (2)

Similar solutions can be obtained for different boundary conditions and for different types of known deformations.

A rapid solution can be obtained if one assumes that the lateral deflection is primarily in the fundamental mode (e.g., uniform thermal gradient on a simple-simple column). Thus the values of the nondimensional parameters can be simply determined with a minimum amount of computation. As an example, the simple-simple column equation can be expressed as

$$\frac{\alpha T - \Delta_o/\ell}{\frac{\pi^2\rho^2}{\ell^2}} - \left(\frac{\Delta_o/\ell}{\frac{\pi^2\rho^2}{\ell^2}} \quad \frac{w^2(\ell/2)}{4\rho^2}\right) - \frac{w^2(\ell/2)}{4\rho^2}\varphi_1 - \left(1 + \frac{EA}{k\ell}\right)\eta_1 = 0 \quad (3)$$

Since

$$w(\ell/2) \sim \frac{C_1 \ell^2}{\pi^2}$$

Similar expressions can be derived for the other boundary conditions.

2.3.3.3 Axial Shortening

The initial axial shortening due to the application of temperature and lateral load is determined as a function of the polynomial coefficients expressing the lateral deflection. The axial shortening is determined as a function of the actual lateral deflection rather than by a function of the amplitude of the characteristic modes, in order to improve the accuracy of the solution (see Eq. 5 of Paragraph 2.3.2).

Assume that the lateral deflection (w_o) is readily available and is expressible as a polynomial of the fourth degree or less. Higher degrees of polynomials can be treated in a manner similar to that indicated below. Differentiating the deflection results in the slope (w_o') which can be squared and integrated over the length of the column to obtain twice the axial shortening

i.e.

$$w_o = a + b\xi + c\xi^2 + d\xi^3 + e\xi^4 \quad (1a)$$

$$w_o' = \frac{1}{\ell}\left[b + 2c\xi + 3d\xi^2 + 4e\xi^3\right] \quad (1b)$$

$$2\Delta_o = \int_o^\ell (w_o')^2 dx = \frac{1}{\ell}\left[b^2 + 2bc + \frac{6bd + 4c^2}{3} + 2be + 3cd + \frac{16ce + 9d^2}{5} + 4de + \frac{16e^2}{7}\right] \quad (1c)$$

2.3.3.3 (Cont'd)

Typical examples for simple-simple columns are presented.

<u>For Constant Thermal Gradient</u> $\left(\frac{\Delta\alpha T}{h}\right)$

$$-\frac{\Delta\alpha T}{h} = \frac{1}{\ell^2}\, m_o\, \xi^o$$

$$j = 0 \text{ and } w_o = \frac{m_o}{(0+1)(0+2)} \left(\xi^{0+2} - \xi\right) \text{ from Eq. (3a) of Paragraph 2.3.3.1.1}$$

$$w_o = \frac{m_o}{2}\left(\xi^2 - \xi\right) = -\frac{\ell^2\,\Delta\alpha T}{2h}\left(\xi^2 - \xi\right) = m_T\left(\xi - \xi^2\right)$$

where

$$m_T = \frac{\ell^2\,\Delta\alpha T}{2h}$$

Substituting $b = m_T$ and $c = -m_T$ in Eq. (1c)

results in

$$2\ell\Delta_o = \frac{1}{3}\, m_T^2 \tag{2a}$$

<u>For Uniform Lateral Load (q)</u>

$$w_o = \frac{q\ell^4}{24EI}\left(\xi - 2\xi^3 + \xi^4\right) = m_q\left(\xi - 2\xi^3 + \xi^4\right)$$

where $m_q = \frac{q\ell^4}{24EI}$

substituting $b = m_q$, $d = -2m_q$, and $e = m_q$

results in $2\ell\Delta_o = .486\, m_q^2$ (2b)

<u>For Combined Uniform Load and Thermal Gradient</u>

$$w_o = \left(m_T + m_q\right)\xi - m_T\,\xi^2 - 2m_q\,\xi^2 + m_q\,\xi^4 \tag{2c}$$

results in

$$2\ell\Delta_o = .333\, m_T^2 + .800\, m_T m_q + .486\, m_q^2 \tag{2d}$$

2.3.3.3 (Cont'd)

It should be noted that any manufacturing or loading eccentricities will augment the lateral deflection parameters (C_i and d_i) by causing an axial shortening when the column is loaded, but should not be included directly in the Δ_o (initial axial shortening because of thermal gradients and lateral loads) of the compatibility equation. The lateral eccentricities due to the various causes are additional and are included in the additional axial motion of the ends. The axial shortening however, is not linear but is proportional to the square of the deformations. Thus the initial axial shortening (Δ_o) must be computed as the difference of the axial shortening between the column including the manufactured eccentricities and the column containing only the manufactured eccentricities (w_{oo}).

$$\text{i.e.}\quad \Delta_o = \int_0^{\ell} (w_q' + w_T' + w_{oo}')^2 \, dx - \int_0^{\ell} (w_{oo}')^2 \, dx \qquad (3)$$

2.3.4 Spring Constant (k)

The value of k to be employed in the solution of the problem can significantly effect the magnitude of the resulting axial load. A column with zero axial restraint ($k = 0$) does not develop any axial load. The load increases with increasing axial restraint until it reaches a maximum for complete restraint ($k = \infty$).

The value of k is the value of the load produced by moving one end of the column a unit distance in the axial direction relative to the other end (assuming that the column offers no resistance). This is the stiffness coefficient defined in Section 4.2.5 of Reference 2-2. If both ends of the column are spring mounted, then the value of k is determined by putting the two end springs in series

$$\text{i.e.}\quad \frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2}$$

$$\therefore\quad k = \frac{k_1 k_2}{k_1 + k_2} \qquad (1)$$

where k - effective axial restraint

k_1, k_2 - axial restraint at the ends of the column

The method of determining the value of k in a composite structure is illustrated below for a truss joint.

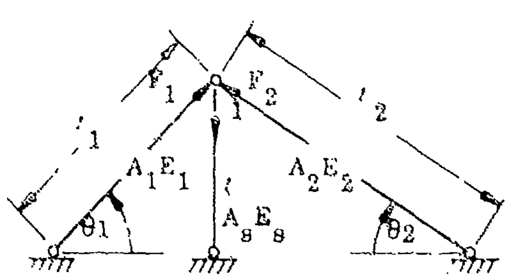


FIGURE 2.3.4-1 DETERMINATE TRUSS JOINT

The equilibrium equations are:

$$F_1 \sin\theta_1 + F_2 \sin\theta_2 = 1 \qquad (2a)$$

$$F_1 \cos\theta_1 = F_2 \cos\theta_2 \qquad (2b)$$

2.3.4 (Cont'd)

For symmetrical geometry ($\theta_1 = \theta_2 = \theta$; $A_1E_1 = A_2E_2 = AE$)

$$F_1 = F_2 = \frac{1}{2 \sin\theta} \tag{2c}$$

$$\frac{1}{k} = \Delta = \frac{F\, \ell/\sin\theta}{AE \sin\theta} = \frac{\ell}{2AE \sin^3\theta} \tag{3a}$$

$$\frac{E_s A_s}{\ell} = \frac{1}{2\sin^3\theta}\left(\frac{E_s A_s}{EA}\right) \quad \text{where } E_sA_s = \text{axial stiffness of strut} \tag{4a}$$

For unsymmetrical geometry

The load will cause a non-vertical motion of center strut and change the angles. For small deformations the following relationships result:

$$F_1 = \frac{1}{\sin\theta_1 (1 + \cot\theta_1 \tan\theta_2)} \quad ; \quad F_2 = \frac{1}{\sin\theta_2(1 + \cot\theta_2 \tan\theta_1)} \tag{2d}$$

$$\frac{1}{k} = \Delta \sim \frac{1}{2}\left(\frac{F_1 \ell_1}{A_1E_1 \sin\theta_1} + \frac{F_2 \ell_2}{A_2E_2 \sin\theta_2}\right)$$

$$= \frac{\ell}{2}\left(\frac{1/A_1E_1}{\sin^3\theta_1 (1 + \cot\theta_1 \tan\theta_2)} + \frac{1/A_2E_2}{\sin^3\theta_2 (1 + \cot\theta_2 \tan\theta_1)}\right) \tag{3b}$$

Thus $$\frac{E_sA_s}{k\ell} \sim \frac{E_sA_s}{2}\left(\frac{1}{A_1E_1\sin^3\theta_1\left(1 + \frac{\tan\theta_2}{\tan\theta_1}\right)} + \frac{1}{A_2E_2\sin^3\theta_2\left(1 + \frac{\tan\theta_1}{\tan\theta_2}\right)}\right)$$

This reduces to $\dfrac{E_sA_s}{k\ell} \sim \dfrac{1}{2\sin^3\theta}\left(\dfrac{E_sA_s}{EA}\right)$ for symmetrical geometry.

2.3.5 Effect of Non-Linearity in Spring or Material

Solutions to the axial load in the column can be obtained even when the axial restraint and/or stiffness of the column varies with the axial load.

The solution of a column with a variable axial restraint can be obtained by superimposing a plot of the flexibility parameter $\left[EA/\ell k = EA/\ell k\,(\eta_1)\right]$ as a function of the axial load parameter (η_1) upon a plot of the solution of the compatibility equation for the load parameter $\left[\eta_1 = \eta_1\left(\frac{EA}{\ell k}\right)\right]$ as a function of the flexibility parameter. The first plot is obtained directly from the spring characteristics whereas the second plot is obtained by varying the value of $EA/k\ell$ to obtain different values of η_1. The intersection of the two plots, as illustrated in Figure 2.3.5-1, will result in a compatible solution.

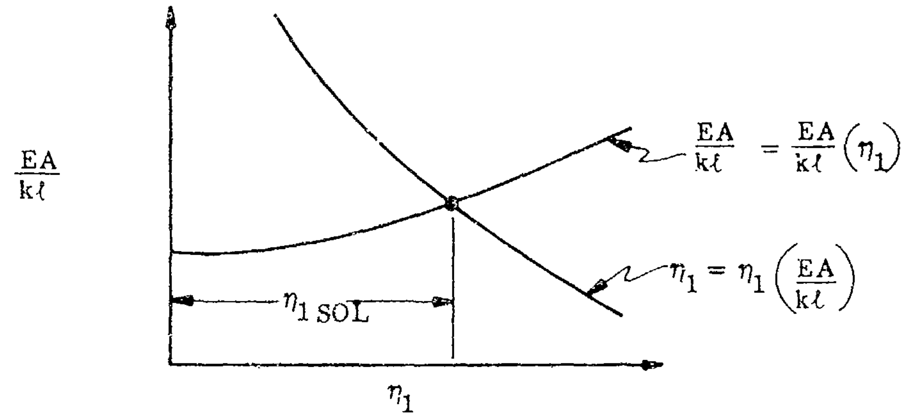


FIGURE 2.3.5-1 FLEXIBILITY VS AXIAL LOAD

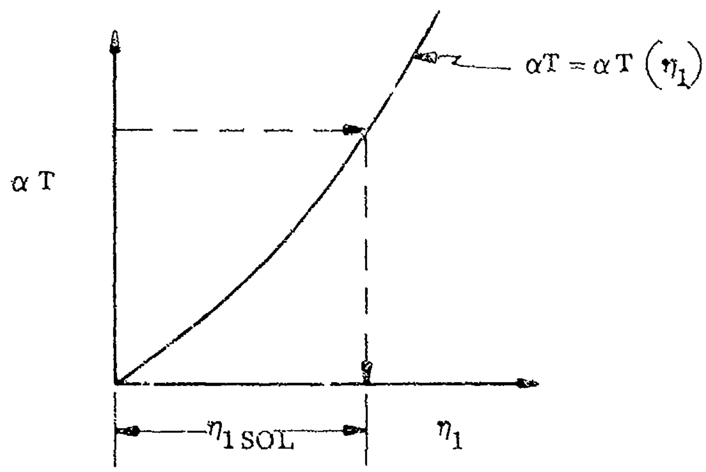


FIGURE 2.3.5-2 AXIAL LOAD VS AVERAGE THERMAL EXPANSION

2.3.5 (Cont'd)

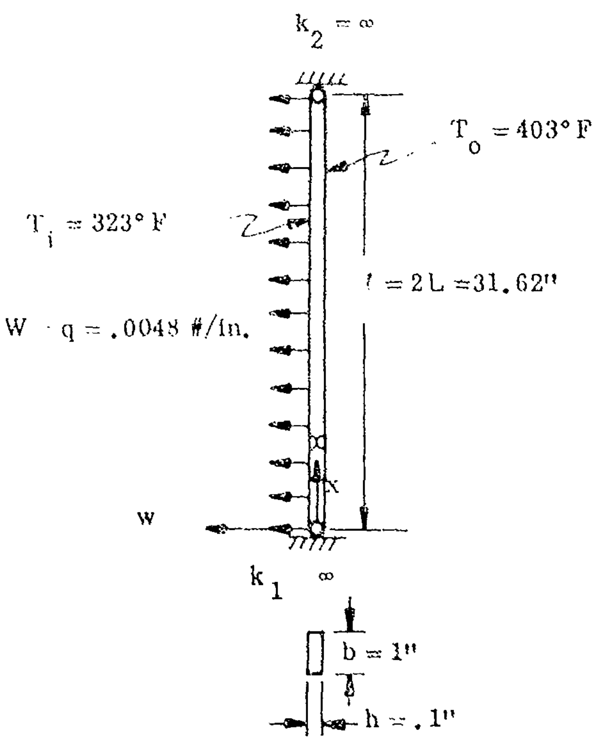
The solution of a column with a load dependent material stiffness (E_s) due to the plasticity of the material can similarly be obtained by a trial and error procedure. Assuming a value of η_1 will determine a value of E_s. This will determine a value of the flexibility parameter $\frac{E_s A}{k\ell}$ which varies linearly with E_s; values of the lateral deflection parameters (C_i) whose lateral load component varies inversely with E_s and whose thermal component is unaffected; and the axial shortening parameters (d_i) which varies as the square of the C_i. Corresponding to these values of η_1, values of $\bar{d}_1$ can be computed and employed in Figures 2.2.4 to obtain values of $\bar{b}$ which can be utilized to calculate αT. The actual value of η_1 results when the calculated value of αT corresponds to the correct value of αT. A graphical approach is illustrated in Figure 2.3.5-2.

This above method can be utilized to solve a problem with a load-dependent axial restraint and a load dependent material stiffness. The above technique assumes that the axial and bending stiffness of the column is not significantly affected by the variation of the stress through the thickness of the cross section but is determined primarily by the mean stress (F/A).

2.3.6 Illustrative Problem

The computation procedure for the approximate solution is relatively simple and is illustrated for a problem which can be directly compared to an "exact" solution obtained from Table 1.5-1.

The temperature on each face is constant along the length with a linear gradient through the thickness.



$k = \infty$

$\ell = 2L = 31.62 = 10\sqrt{10}$

$h = .1$

$b = 1$

$\alpha = 6(10)^{-6}$ in/in/° F

$E = 12(10)^6$ pounds per square inch

$\Delta T = T_i - T_o = -80°$ F

$T = \frac{T_o + T_i}{2} = 363°$ F

$W = q = .0048$ #/"

2.3.6 (Cont'd)

AXIAL EXPANSION

From Eq. (1b) of Paragraph 2.2.4

$$\alpha T = \alpha \frac{T_o + T_i}{2} = 6(10)^{-6} \; 323 = .0021780$$

AXIAL SHORTENING

From Eq. (2d) of Paragraph 2.3.3.3

$$\frac{\Delta_o}{\ell} = \frac{1}{\ell^2}\left[\frac{1}{6} m_T^{\,2} + .400\, m_T m_q + .243\, m_q^{\,2}\right]$$

but

$$m_T = \frac{\ell^2 \Delta\alpha T}{2h} = \frac{1000 \;\; 6(10)^{-6} \; (-80)}{2(.1)} = -2.4''$$

and

$$m_q = \frac{q\,\ell^4}{24EI} = \frac{+.0048\;(10)^6}{(24)12(10)^6 \;\; \frac{1}{12}(.1)^3} = +.2''$$

$$\therefore \quad \frac{\Delta_o}{\ell} = \frac{1}{1000}\left[\frac{1}{6}(2.4)^2 + .4(2.4)(-.2) + .243(.2)^2\right] = 7.777\;(10)^{-4}$$

From Eq. (2c) of Paragraph 2.2.4

$$\epsilon_1 = \lambda_1 \rho^2 = \lambda_1\left(\frac{I}{A}\right) = \frac{\pi^2}{\ell^2}\frac{h^2}{12} = \frac{\pi^2}{1000} \;\; \frac{(.1)^2}{12} = 8.225\;(10)^{-6}$$

$$\therefore \quad \frac{\alpha T}{\epsilon_1} = 264.8 \quad \text{and} \quad \frac{\Delta_o}{\ell \epsilon_1} = 94.56$$

EXPANSION OF CURVATURE

From Eq. (2c) of Paragraph 2.3.3.3

$$w_o = (m_T + m_q)\;\xi - m_T\;\xi^2 - 2m_q\;\xi^3 + m_q\;\xi^4 \tag{1a}$$

$$\therefore \quad w_o' = \frac{1}{\ell}\left[m_T + m_q - 2m_T\;\xi - 6m_q\;\xi^2 + 4m_q\;\xi^3\right] \tag{1b}$$

$$\therefore \quad w_o'' = \frac{1}{\ell^2}\left[-2\,m_T - 12\,m_q\;\xi + 12\,m_q\;\xi^2\right] \tag{1c}$$

2.3.6 (Cont'd)

Direct substitution in the Fourier sine expansion or the use of Table 2.3.3.1.2-1 will enable the determination of the magnitude of the curvatures. Direct substitution is employed in this illustration to obtain general equations for the case of uniform load and thermal gradients. The Fourier coefficients defined by Eq. (2b) of Paragraph 2.3.3.1.2 are

$$S(0,i) = \frac{1-(-1)^i}{i\pi}$$

$$S(1,i) = -\frac{(-1)^i}{i\pi}$$

and

$$S(2,i) = \frac{-(-1)^i}{i\pi} + \frac{2}{(i\pi)^3}\left[(-1)^i - 1\right]$$

From Eq. (2a) of Paragraph 2.3.3.1.2

$$\therefore \quad C_i = \frac{2}{\ell^2}\sum_j \sum_i m_j \quad S(j,i)$$

$$C_i = \frac{2}{\ell^2}\left[(-2\,m_T)\left(\frac{1-(-1)^i}{i\pi}\right) + (-12\,m_q)\left(\frac{-(-1)^i}{i\pi}\right)\right.$$

$$\left. + (12\,m_q)\left(\frac{-(-1)^i}{i\pi} + \frac{2}{(i\pi)^3}\left[(-1)^i - 1\right]\right)\right]$$

$$C_i = \frac{2}{\ell^2}\left[(-2\,m_T)\frac{(1-(-1)^i)}{i\pi} - \frac{24\,m_q}{(i\pi)^3}(1-(-1)^i)\right]$$

$$C_i = -\frac{4}{\ell^2}(1-(-1)^i)\left[\frac{m_T}{i\pi} + \frac{12\,m_q}{(i\pi)^3}\right]$$

$$\therefore \text{ for } \quad C_{i(odd)} \quad \frac{-\ell^2\,C_{2k+1}}{2} = \frac{4/\pi}{2k+1}\,m_T + \frac{(48/\pi^3)\,m_q}{(2k+1)^3} \tag{2a}$$

$$\text{and for } \quad C_{i(even)} \quad C_{2k} = 0 \tag{2b}$$

The values of C_i are then calculated. The same values would be obtained from Table 2.3.3.1.2-1 $\left[\frac{C_i \ell^2}{2} = \Sigma \Sigma m_j S(j, i)\right]$

$$\therefore \quad -\frac{\ell^2 C_1}{2} \begin{cases} = 4/\pi \ (m_T) + 48/\pi^3 \ (m_q) \\ = 1.27324(-2.4) + 1.548076(+.2) \\ = -3.05578 + .30962 = -2.746 \end{cases}$$

$$-\frac{\ell^2 C_3}{2} = -\frac{1}{3}(3.05578) + \frac{1}{9}(.30962) = -1.007$$

$$-\frac{\ell^2 C_5}{2} = -\frac{1}{5}(3.05578) + \frac{1}{25}(.30962) = -.609$$

$$-\frac{\ell^2 C_7}{2} = -\frac{1}{7}(3.05578) + \frac{1}{49}(.30962) = -.435$$

PERTINENT PARAMETERS

From Eqs. (2b) and (4b) of Paragraph 2.3.1

$$d_1 = \left(\frac{\ell^2 C_1}{2}\right)^2 \frac{1}{\pi^4} \rho^2 i^2 \quad \text{and} \quad \frac{d_i \eta_i}{\eta_1} = \frac{d_i}{i^2}$$

$$\therefore d_1 = \frac{(2.746)^2}{\pi^4 \frac{(.1)^2}{12}} = 92.895$$

similarly

$$d_3 = 1.388 \quad \text{and} \quad \frac{d_3 \eta_3}{\eta_1} = d_3/3^2 = .154$$

$$d_5 = .183 \qquad \frac{d_5 \eta_5}{\eta_1} = d_5/5^2 = .007$$

$$d_7 = .047 \qquad \frac{d_7 \eta_7}{\eta_1} = d_7/7^2 = .001$$

$$\therefore \sum_{i=1}^{8} d_i = d_1 + d_3 + d_5 + d_7 = 94.513$$

and

$$\frac{\sum_{i=2}^{8} \eta_i d_i}{\eta_1} = d_3/3^2 + d_5/5^2 + d_7/7^2 = .162$$

Employing Eq. (9a) of Paragraph 2.24 and including correction for finite sum approximation of the initial shortening (Eq. (5) of Paragraph 2.3.2) results in

$$0 = \frac{\alpha T}{\epsilon_1} - \frac{\Delta_o}{\ell \epsilon_1} - \left(\frac{\Delta_o}{\ell \epsilon_1} - \sum_{i=1}^{8} d_i \right) - d_1 \varphi_1 - \left(1 + \frac{EA}{k\ell} + 2 \sum_{i=2}^{8} \frac{\eta_i d_i}{\eta_1} \right) \eta_1 \qquad (3)$$

Substituting the calculated values results in

$$0 = (264.8 - 94.555) - (94.555 - 94.513) - 92.895\,\varphi_1 - (1.234)\,\eta_1$$

$$0 = 170.203 - 92.895\varphi_1 - (1.234)\,\eta_1$$

$$0 = 137.93 - 75.28\varphi_1 - \eta_1 = \bar{b} - \bar{d}_1 \varphi_1 - \eta_1$$

Entering Figure 2.2.4-2 with $\bar{b} = 137.93$ and $\bar{d}_1 = 75.28$ results in the solution $\eta_1 = .407$.

AXIAL LOAD

From Eq. (3) of Paragraph 2.3.2

$$F = AE\,\epsilon_1 \eta_1 = (1.1)(1)(12)(10)^6\, 8.225\,(10)^{-6}\, .407 = 4.017\#$$

LATERAL DEFLECTION

From Eq. (4a) of Paragraph 2.3.2

$$w_{max} = w(\ell/2) = \Sigma \frac{w_{oi}}{1-\eta_i} = -\frac{\ell^2}{\pi^2} \Sigma \frac{C_i}{i^2(1-\eta_i)} = -\frac{2}{\pi^2} \Sigma \frac{\ell^2 C_i}{2i^2(1-\eta_i)}$$

2.3.6 (Cont'd)

$$\therefore \quad w_{max} \sim -\frac{2}{\pi^2}\left[\frac{-2.74616}{1-.407} + \frac{-1.00712}{9(1-.407/9)} + \frac{-.60867}{25(1-.407/25)} + \frac{-.43523}{49(1-.407/49)}\right]$$

$$w_{max} \sim .97''$$

The geometry and loads employed in this illustrative problem results in parameters which correspond to an exact solution found in Table 1.5-1.

These parameters are

$$\overline{T}_D = \alpha\left(\frac{L}{h}\right)^2 (T_o - T_1) = 12.0$$

$$\overline{W} = \frac{12W}{Eb}\left(\frac{L}{h}\right)^4 = 3.0$$

$$\overline{T} = \alpha\left(\frac{L}{h}\right)^2 (T_o + T_1) = 108.9$$

A comparison of the exact and approximate solutions is presented below.

	Exact Solution	Approximate Solution
$\overline{\lambda}$	- 1.000	- 1.005
η_1	.405	.407
F	4.01#	4.02#
w_{max}	.92"	.97"

Note that the approximate solution results in slightly larger values. The approximate method, however can be applied to more general types of loadings and boundary conditions.

It should be noted that the illustrated example shown in Figure 1.7-1 of Section 1 is solved by an interpolation of the "exact" tabular values. The approximate graphical procedure as well as the interpolation of tables procedure is subjected to relatively ~~greater~~ errors in the vicinity of low load ratios. This is because of the greater relative significance of the higher modes in the graphic approach and the large slope of the $\overline{T}$ vs $\overline{\lambda}$ (as illustrated in Figure 1.5-2 of Secti . 1 of the tabular solution which permits large variations in $\overline{\lambda}$ for small variations in $\overline{T}$. Fortunately the design of the column is not determined by this condition of low axial load. The interpolation and graphical solutions are not subject to significant errors, however, when the load ratios are higher.

A comparison of the interpolation solution and of the approximate graphical solution of this report is presented as follows:

	Interpolated Sol.	Approx. Graphical Sol.
$\bar{\lambda}$	-.524	-.607
η_1	.111	.155
F	27.4	37.2
w_{max}	.16	.18

2.4 REFERENCES

2-1. Switzky, H., "Approximate Solution For an Axially Restrained Column Subjected to Elevated Temperatures and Lateral Loads," Republic Aviation Corporation Report No. ARD-679-4, September 1961.

2-2. Switzky, H., Forray, M., and Newman, M. "Thermo-Structural Analysis Manual"-Volume I, Republic Aviation Corporation Report No. RAC 679-1, September 1960, revised November 1961 (to be published as WADD TR 60-517, Vol. I).

SECTION 3

APPROXIMATE SOLUTION FOR THE BUCKLING OF ECCENTRIC COLUMNS

by

H. Switzky

SECTION 3

APPROXIMATE SOLUTION FOR THE BUCKLING OF ECCENTRIC COLUMNS

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SECTION 3 - APPROXIMATE SOLUTION FOR THE BUCKLING OF ECCENTRIC COLUMNS

3.1 SUMMARY

An approximate solution $\left(\bar{F}_1 = \frac{K}{\ell^2} E_{So} I_o \left[1 - \left\{\sqrt{6}\left(\frac{a_{10}}{r}\right)\left(1 - \frac{E_{To}}{E_{So}}\right)\right\}^{2/3}\right]\right)$ is obtained for the buckling of an eccentric column which includes the effects of the stress level, the stress-strain relationship, and the initial eccentricity.

The analysis technique is presented in a nondimensional form to permit the analyst to consider various cross sections, boundary conditions, materials and degrees of eccentricity. The type of cross section is reflected in the I/A ratio which defines the square of the radius of gyration (r). The boundary conditions are contained in the value of K/ℓ^2 which consider the end fixity and length of the column. The material characteristics are reflected in material parameters (E_A, σ_o, β) which represent the stress-strain relationship. The nondimensional analysis graphs are presented for several values of the eccentricity ratio $\left(\frac{a_{10}}{r}\right)$ which may occur because of initial waviness, eccentric loading, lateral loads, or thermal gradients. Analysis for intermediate values of the eccentricity can be conducted by interpolation.

Illustrative problems are presented to indicate the computation procedure and the effect of the initial eccentricity upon the stability of the structure.

3.1.1 Definition of Symbols

The following symbols are used throughout this section:

a_{10}	Original amplitude (eccentricity) of fundamental mode
h	Depth of cross section of the column
ℓ	Length of column
m_j	Coefficient expressing initial deformations of the column as a power series
q	Lateral load acting on column
r	Radius of gyration of cross section
w	Lateral deflection of column
x	Axial coordinate of column
z'	Distance from reference axis
$\bar{z}'$	Distance from reference axis to bending axis
$\bar{z}_o'$	Distance from reference axis to centroidal axis $\left(\bar{z}_o' = \int z' dA / \int dA\right)$
z	Distance from bending axis
A	Area of cross section
$C(j, 1)$	Fourier expansion coefficient $\left(C(j,1) = \int_0^1 \xi^j \cos 2\pi\xi \, d\xi\right)$
$E = E_A$	Initial slope of the σ vs ϵ_σ curve
E_S	Secant modulus of the σ vs ϵ_σ curve $\left(E_S = \sigma/\epsilon_\sigma\right)$
E_{So}	Secant modulus at the bending axis
E_T	Tangent modulus, slope of the σ vs ϵ_σ curve $\left(E_T = \partial\sigma/\partial\epsilon_\sigma\right)$
E_{To}	Tangent modulus at the bending axis

3.1.1 (Cont'd)

$\overline{EA}$	Axial stiffness of cross section $\left(\overline{EA} = \int E_S \, dA\right)$
$\bar{EI}$	Bending stiffness of cross section $\left(\bar{EI} = \int E_S z^2 \, dA\right)$
$\bar{\bar{EI}}$	Buckling stiffness of cross section $\left(\bar{\bar{EI}} = \bar{EI} + \varkappa \frac{\partial \bar{EI}}{\partial \varkappa} = \bar{F}_1 \Big/ \frac{K}{\ell^2}\right)$
F	Axial load on structure (compression positive)
F_1	Buckling load of column with zero eccentricity or a linear material
$\bar{F}_1$	Buckling load of column $\left(\bar{F}_1 = \frac{K}{\ell^2} E_{So} I_o \left[1 - \left\{\sqrt{6}\left(\frac{a_{10}}{r}\right)\left(1 - \frac{E_{To}}{E_{So}}\right)\right\}^{2/3}\right]\right)$
F_E	Euler Buckling load $\left(F_E = \frac{K}{\ell^2} EI_o\right)$
I_o	Second moment of area (inertia) of cross section $\left(I_o = \int (z' - \bar{z}_o')^2 \, dA\right)$
K	Stability constant depending upon boundary conditions and the bending stiffness distribution along the columns $\left(K = \ell^2 \frac{\delta \varkappa}{\delta w} = \frac{\ell^2 \int_o^{\ell} \varphi (w_1'')^2 \, dx}{\int_o^{\ell} (w_1')^2 \, dx}\right)$
M	Moment acting on cross sections (Positive M causes compression in positive fibers).
Q_o	Third moment of area of cross section $\left(Q_o = \int (z' - \bar{z}_o')^3 \, dA\right)$
$S(j,1)$	Fourier expansion coefficient $\left(S(j,1) = \int_o^1 \xi^j \sin \pi \xi \, d\xi\right)$
T	Temperature rise above datum
α	Coefficient of linear thermal expansion
α	Parameter expressing variation of secant modulus in the cross section $\left(\alpha = \frac{\varkappa}{\epsilon_o}\left(1 - \frac{E_{To}^{\gamma}}{E_{So}}\right)\right)$
β	Nondimensional parameter employed in mathematical definition of stress-strain relationship (Section 3 of Reference 3-1)
γ	Nondimensional parameter expressing the average variation of the tangent modulus in the cross section $\left(\gamma = \int_o^{z} E_T \, dz \big/ z E_{To}\right)$
$\Delta\alpha T$	Difference in thermal expansion
δ	Operator denoting a small variation
ϵ	Axial strain of cross section
ϵ_σ	Axial strain caused by stress $(\epsilon_\sigma = \epsilon - \alpha T)$
ϵ_1	Average axial strain corresponding to an axial load F_1
ϵ_o	Axial strain at the bending axis
$\bar{\epsilon}_1$	Average axial strain corresponding to an axial load $\bar{F}_1$
η	Shift of bending axis $(\eta = \bar{z}_o' - \bar{z}')$
$\varkappa$	Curvature
ξ	Nondimensional axial coordinate $(\xi = x/\ell)$
σ	Axial stress of cross section (compression positive)

3.1.1 (Cont'd)

σ_o Axial stress at bending axis

σ_o Reference stress in nondimensional stress-strain relationship (Section 3 of Reference 3-1)

ω Nondimensional parameter expressing the variation of the bending stiffness along the length of the column $(\omega(x) = \overline{EI}/E_o I_o)$

Φ Nondimensional parameter $\left(\Phi = \left({}^{E}A/\sigma_o\right)\left(\frac{KI}{Ab^2}\right) = \frac{E_A \epsilon_1}{\sigma_o}\right)$

$\bar{\Phi}$ Nondimensional parameter $\bar{\Phi} = \left({}^{E}A/\sigma_o\right)\left(\frac{KI}{Ab^2}\right)\left[1 - \left\{\sqrt{6}\left(\frac{a_{10}}{r}\right)\left(1 - \frac{\bar{E}_T}{E_1}\right)\right\}^{2/3}\right] = \frac{E_A \bar{\epsilon}_1}{\sigma_o}\Big)$

SUBSCRIPTS

M Caused by mechanical load

T Caused by temperature

1 Pertaining to the first (fundamental) mode

o Pertaining to initial or datum

3.1.2 Discussion of the Problem

The stability of a structure is a very complex problem. Exact solutions exist only for very few special cases. Approximations must be attempted when the solution is complicated by variations (reductions) of the stiffness with the applied load because of the resulting non-linearity of the equation. The reduction in the stiffness is caused by a non-linear structural material. The non-linear stress strain relationship reduces the stiffness of the structure by lowering the secant modulus and shifting the neutral axis.

Temperature, time, and the eccentricities of the structure tend to reduce the allowable magnitude of the applied load on the structure. Elevated temperatures reduce the stiffness of the structure, increase the non-linearity of the material because of plasticity at the stresses caused by the applied and thermal stresses, and usually increase the eccentricity of the structure. The axial forces acting through the eccentricity of the structure imposes moments upon the structure which increase at a greater rate than the applied load. These moments cause a variation of stresses through the cross sections which can reduce the bending stiffness. The larger the eccentricity the earlier the initiation of the non-linearity of the material and the lower the stability of the structure. The bending stiffness can also decrease with time because of creep of the material.

The approach, employed in this section, to examine the stability of a column (Figure 3.1.2-1) is to determine when the increase of external moment acting on the column cross sections tend to become greater than the increase of internal moment that can be generated by the cross sections. The axial load acting on the column at this time is the buckling load and is a function of the boundary conditions, the bending stiffness of the cross sections, and the rate that the bending stiffness is decreasing. The bending stiffness is a function of the cross-section, the magnitude of the stresses and their distribution and the stress-strain relationship. The bending stiffness usually decreases with an increase in the applied load, temperature, time, or eccentricity of the column. Thus the column becomes unstable when the applied load becomes equal to the buckling load which is determined by the bending stiffness distribution and its rate of decrease. This can occur by increasing the applied load and/or decreasing the magnitude of the buckling load. The buckling load is reduced by the eccentricity, the temperature, and time as indicated previously.

3.1.2 (Cont'd)

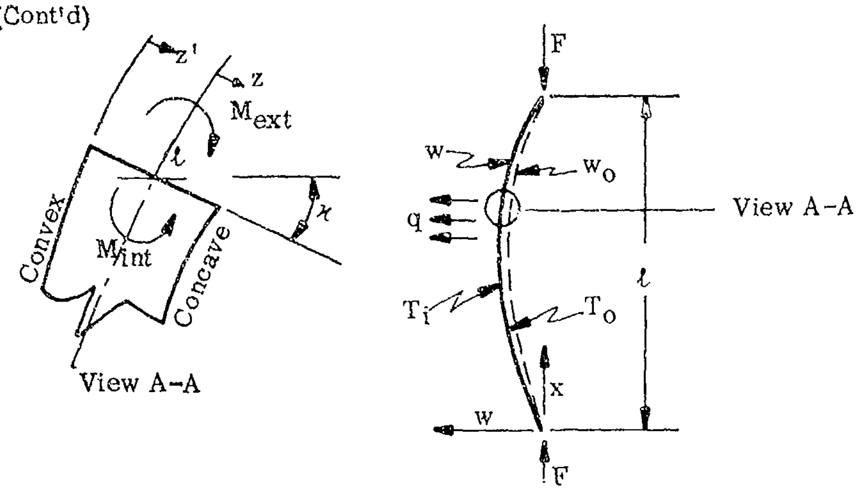


FIGURE 3.1.2-1 ECCENTRIC COLUMN SUBJECTED TO AXIAL LOADS

The evaluation of the buckling load requires the determination of the stiffness of the column and its rate of change. This is complicated by the shifting of the bending axis towards the convex side of the cross section because the higher stress and strain levels on the concave side reduce the secant modulus. The stiffness relationships, derived in Appendix A of Reference 3-2, are employed with the stability criterion described previously to obtain an approximate solution for the buckling load of the column in terms of the stress and lateral deflections. The solution is then approximated in terms of average stress level and initial eccentricity which can be readily computed. The initial eccentricities may result from the unloaded shape, eccentric loading, lateral loads, or thermal gradients. Methods of computing the initial eccentricity due to load and temperature are presented in Section 2 and summarized in this section.

An analogous approach can be employed to transform the loads or stresses to strains. Thus the column becomes unstable when the average axial strain becomes equal to a buckling strain. This approach is most convenient for a nondimensional presentation of the analysis.

The solution is predicated upon the following assumptions:

(1) The bending strains are small compared to the axial strains in the column.

(2) The temperature distribution can result in deformations and reductions in the moduli but do not cause significant thermal stresses.

(3) There is a one-to-one relationship between the stress (σ) and the strain (ϵ_σ) for each fiber of the column. This assumes that there is no stress reversal throughout the loading history. It is also assumed that the stress-strain relationship can be approximated to a sufficient degree of accuracy by the relationship $\left[\frac{E_A \epsilon}{\sigma_o} = (1-\beta)\, \sigma/\sigma_o + \beta \sinh \sigma/\sigma_o\right]$ defined and described in Section 3 of Reference 3-1.

The approximate solution, which results from these assumptions, is of a form which does not violate known solutions of special cases and is indicative of the structural behavior in experiments.

3.2 ANALYSIS

A column subjected to loads and temperature (Figure 3.1.2-1) must satisfy equilibrium. Thus the change in applied moment (M_{ext}) must be equal to the change in the internal moment (M_{int}) The changes in external moment arise from changes in the axial load (F) and the lateral deflection (w). (The effect of elastic supports in introducing changes in the moment is reflected in the value of the stability constant K). The change in the internal moment is evidenced by a change in the curvature ($\varkappa_M$) and a possible change in the bending stiffness ($\overline{EI}$).

Referring to Figure 3.1.2-1, we note the equilibrium requirements.

$$M_{ext} + M_{int} = 0 \tag{1a}$$

and

$$-\delta(M_{ext}) = \delta(M_{int}) \tag{1b}$$

evaluating the change in moments, we obtain

$$-\delta(M_{ext}) = -\delta(Fw) = -\left[F(\delta w) + w(\delta F)\right] \tag{1c}$$

and

$$\delta(M_{int}) = \delta(\overline{EI}\,\varkappa_M) = \left[\overline{EI}(\delta\varkappa_M) + \varkappa_M(\delta\overline{EI})\right] \tag{1d}$$

$$\therefore \quad -\left[F(\delta w) + w(\delta F)\right] = \left[\overline{EI}(\delta\varkappa_M) + \varkappa_M(\delta\overline{EI})\right] \tag{1e}$$

If the load is monotonically increasing, then the column will fail when the buckling load (F_1) is applied. No additional incremental load can be applied so that the buckling load is defined by setting δF equal to zero. The above buckling criterion is equivalent to finding the load on a structure for which the deflection is undefined (Figure 9.1-1b of Reference 3-1). It is also equivalent to determining the load on the structure at which the ratio of $\delta F/\delta w$ is zero, where δF is the incremental load necessary to cause an incremental deflection (δw). The latter buckling criteria ($\delta F/\delta w = 0$) can also be employed to determine the stability of a column which exhibits creep.

Setting $\delta F = 0$ and $F = F_1$ in equation (1e) results in

$$-\left[\bar{F}_1\delta w + w(0)\right] = \overline{EI}\,\delta\varkappa_M + \varkappa_M\delta\overline{EI} \tag{2a}$$

$$\therefore \quad F_1 = -\left[\overline{EI}\,\frac{\delta\varkappa_M}{\delta w} + \varkappa_M\,\frac{\delta\overline{EI}}{\delta w}\right] = -\frac{\delta\varkappa_M}{\delta w}\left(\overline{EI} + \varkappa_M\,\frac{\delta\overline{EI}}{\delta\varkappa_M}\right)$$

$$F_1 = -\frac{\delta\varkappa_M}{\delta w}\,\overline{EI} \tag{2b}$$

Thus the buckling load is a function of the ratio of the change of curvature to the change of lateral deflection and of the bending stiffness modified by an expression indicating the rate of change of bending stiffness with curvature.

The first expression $\delta\varkappa_M/\delta w$ is relatively simple to calculate if we assume that the deformation modes of the given structure do not change as the axial load is increased to the buckling load. Thus it is assumed that a pin ended column of constant bending stiff-

ness, which buckles elastically in a sine wave, will buckle in a sine wave even if it becomes plastic. This condition is satisfied as long as the ratio of the bending stiffness distribution $\left(\varphi(x) = \overline{EI}(x)/E_o I_o\right)$ along the column does not change significantly with the axial load. The stiffness can change due to plasticity but it is assumed that the φ ratio does not change significantly. This is consistent with our assumption that the bending stresses are small compared to the axial stresses so that the material moduli remain approximately equal (for constant cross-section area). Thus the value of $\delta x_M/\delta w$ is assumed equal to the value of the "linear" column. This is the classical stability coefficient found in various textbooks which can be expressed as the curvature to deflection ratio as indicated above or by the general expression of Eq. (1a) of Paragraph 2.3.1.

$$- \frac{\delta x_M}{\delta w} = \frac{F_1}{\overline{\overline{EI}}} = \lambda_1 = \frac{\int_o^{\ell} \varphi \, (w_1'')^2 \, dx}{\int_o^{\ell} (w_1')^2 \, dx} = \frac{K}{\ell^2} \tag{3}$$

Values of K can be found in various texts (e.g. References 3-3, and 3-4).

As an example for a pin-ended column of constant EI (i.e. $\varphi = 1$)

$$- \frac{\delta x_M}{\delta w} = - \frac{\delta\left(\frac{-\pi^2}{\ell^2} \sin \frac{\pi x}{\ell}\right)}{\delta\left(\sin \frac{\pi x}{\ell}\right)} = \frac{\pi^2}{\ell^2} = \frac{K}{\ell^2} \tag{4a}$$

$$\text{or} \qquad \lambda_1 = \frac{\int_o^{\ell} (1)\left(-\frac{\pi^2}{\ell^2} \sin \frac{\pi x}{\ell}\right)^2 dx}{\int_o^{\ell}\left(\frac{\pi}{\ell} \cos \frac{\pi x}{\ell}\right)^2 dx} = \frac{\pi^2}{\ell^2} = \frac{K}{\ell^2} \tag{4b}$$

$$\therefore \qquad K = \pi^2 \tag{4c}$$

The second expression $\left(\overline{\overline{EI}} = \overline{EI} + x_M \frac{\delta \overline{EI}}{\delta x_M}\right)$ is evaluated by utilizing the definition of the bending stiffness derived in Appendix A of Reference 3-2 which approximates the effects of the bending stress.

From Eq. (A10b) of Reference 3-2

$$\overline{EI} \approx E_{So} I_o \, (1 - 2\alpha^2 r^2) \tag{5a}$$

where

$$\alpha = \frac{x_M}{\epsilon_o} \left(1 - \frac{\sigma_o}{E_{So}} \gamma\right) \tag{5b}$$

3.2 (Cont'd)

and $$\gamma = \int_0^z E_T dz / z E_T \,. \tag{5c}$$

Substituting Eq. (3), (5a), and (5b) in Eq. (2b) results in

$$\bar{F}_1 = \frac{K}{\ell^2} E_{So} I_o \left(1 - 6\alpha^2 r^2\right) \tag{6}$$

The solution for the buckling load is now expressed in terms of geometry and boundary conditions (ℓ, I_o, r, K), the stress level at the neutral axis (E_{So}, E_{To}) and the stress distribution $\left(\alpha = \frac{\chi_M}{\epsilon_o}\left(1 - \frac{E_{To}}{E_{So}}\gamma\right)\right)$. Unfortunately the stress distribution parameter α is not specifically defined but varies in a complex way with the applied load. It varies directly with the curvature (χ_M) which increases nonlinearly with the load, inversely with the axial strain (ϵ_o) which is defined by the stress-strain relationship (Figure 3.2-1) and directly with the stress distribution factor $\left(1 - \frac{E_{To}}{E_{So}}\gamma\right)$ which increase with load and curvature. Some additional approximations are required to reduce the solution to a simple form expressible in terms of the initial conditions. Each of the approximations employed introduces small over- or under-estimates of the buckling load. It is hoped that the combined effect of all the approximations will result in a reasonably accurate solution that considers the effects of eccentricity.

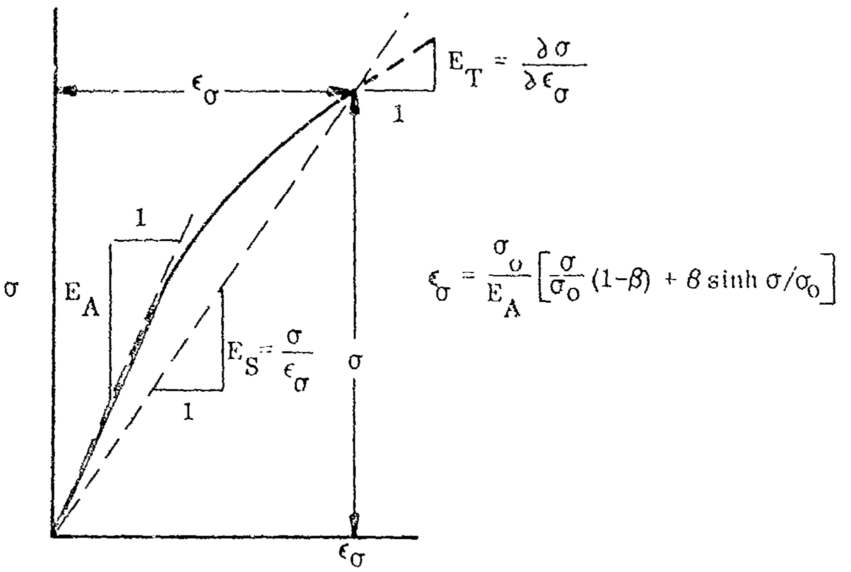


FIGURE 3.2-1 STRESS-STRAIN RELATIONSHIP

The first approximation is to assume that the lateral deflection will increase as a rectangular hyperbola of the form

$$w = \frac{a_{10} w_1}{1 - F/F_1} \tag{7}$$

3.2 (Cont'd)

where w = the lateral deflection

w_1 = fundamental deflection mode

a_{10} = initial amplitude of the fundamental mode

(The higher modes need not be considered in the buckling load problem since the column will buckle in the fundamental mode)

F_1 = buckling load for a linear or straight column

where $$F_1 = \frac{K}{\ell^2} E_{So} I_o \tag{8}$$

The second approximation is to assume that γ has the magnitude of unity in evaluating the value of α. Under the assumption of small bending stresses, the magnitude of γ should be very close to but slightly lower than 1.

The third approximation is to assume the average axial strain (ϵ_o) to be equal to the value of $F_1/E_{So}A$ at buckling.

The above three approximations are consistent with the assumption of relatively small bending strains and result in a slight underestimation of α and a resulting slight overestimate of $\bar{F}_1$.

The final approximation is to evaluate α with the stress distribution which exists at the cross section with the maximum lateral deflection. This assumption is made because the stability is primarily a function of the square of the curvature (see Eq. (3)) which is largest in the vicinity of the maximum lateral deflection (for columns of constant cross sections). This approximation of the bending to axial stress ratio overestimates α and results in an underestimate of $\bar{F}_1$ and compensates, to some degree, for the overestimates resulting from the small bending approximations.

The approximations result in the following equation

$$\bar{F}_1 = \frac{K}{\ell^2} E_{So} I_o \left[1 - \left\{ \sqrt{6} \left(\frac{a_{10}}{r} \right) \left(1 - \frac{E_{To}}{E_{So}} \right) \right\}^{2/3} \right] \tag{9}$$

These approximations cannot be rigorously justified but they result in an expression for the stability of the column that can be simply applied to the analysis of a very complex problem and which retains the correct sense for the effect of the parameters. A well controlled test program is recommended to evaluate the accuracy of the resulting formulation and to supply empirical correction factors, as needed.

An examination of the experimental data of Reference 3-5 was conducted in Appendix C of Reference 3-2 and indicated good agreement with the results for specimens tested with eccentricities caused by eccentric loads or thermal gradients. The predicted results were slightly unconservative. Better agreement can possibly be obtained between the experimental results and the theoretical predictions by statistically determining the best value for the expression ($\sqrt{6}\, a_{10}/r$). The graphs (Figures 3.3.1-1 through -10) can still be employed by modifying the indicated value of a_{10}/r. Additional test data is necessary, however, to examine the reliability of the above approximations for greater eccentricities and larger buckling stresses than those reported in Reference 3-5.

3.2 (Cont'd)

Using Eq. (9), the average buckling stress becomes

$$\bar{\sigma}_1 = \frac{\bar{F}_1}{A} = E_{So}\,\frac{Kr^2}{\ell^2}\left[1 - \left\{\sqrt{6}\left(\frac{a_{10}}{r}\right)\left(1 - \frac{E_{To}}{E_{So}}\right)\right\}^{2/3}\right] \tag{10}$$

and the average buckling strain becomes

$$\bar{\epsilon}_1 = \frac{\bar{\sigma}_1}{E_{So}} = \frac{Kr^2}{\ell^2}\left[1 - \left\{\sqrt{6}\left(\frac{a_{10}}{r}\right)\left(1 - \frac{E_{To}}{E_{So}}\right)\right\}^{2/3}\right] \tag{11a}$$

Since $$\epsilon_1 = \frac{\sigma_1}{E_{So}} = \frac{F_1/A}{E_{So}} = \frac{K}{\ell^2}\,\frac{E_{So}I_o}{E_{So}A} = K\,\frac{r^2}{\ell^2} \tag{11b}$$

$$\therefore\ \frac{\bar{\epsilon}_1}{\epsilon_1} = \left[1 - \left\{\sqrt{6}\left(\frac{a_{10}}{r}\right)\left(1 - \frac{E_{To}}{E_{So}}\right)\right\}^{2/3}\right] \tag{11c}$$

Letting $\bar{\Phi} = \frac{E_A}{\sigma_o}\,\bar{\epsilon}_1$ and $\Phi = \frac{E_A}{\sigma_o}\,\epsilon_1$

We obtain from Eqs. (9), (10), and (11c)

$$\frac{\bar{F}_1}{F_1} = \frac{\bar{\sigma}_1}{\sigma_1} = \frac{\bar{\epsilon}_1}{\epsilon_1} = \frac{\bar{\Phi}}{\Phi} = \left[1 - \left\{\sqrt{6}\left(\frac{a_{10}}{r}\right)\left(1 - \frac{E_{To}}{E_{So}}\right)\right\}^{2/3}\right] \tag{11d}$$

The factor $\left[1 - \left\{\sqrt{6}\left(\frac{a_{10}}{r}\right)\left(1 - \frac{E_{To}}{E_{So}}\right)\right\}^{2/3}\right]$ approximates the effect of the eccentricity and stress distribution. The effect is more pronounced with larger initial eccentricities or higher average stresses. It should be noted at this time that the factor was determined for sections which were symmetrical about the centroidal axis parallel to the bending axis ($Q_o = 0$). The stability of the column should decrease slightly with increasing values of Q_o/I_o [as indicated by a comparison of the bending stiffness in the plastic range for $Q_o \neq 0$ with $Q_o = 0$ (see Eqs. (A10a) and (A10b) of Reference 3-2].

3.3 TECHNIQUE

The final formulation for the approximate solution for the buckling of an eccentric column is presented by the non-linear Eqs. (9), (10), or (11) of Sub-section 3.2. It is necessary to resort to graphical solutions in order to solve these equations. In order to simplify the analysis, a nondimensional solution is presented in Figure 3.3.1-1 to -10. The graphs are based upon the stress-strain relationship presented in Section 3 of Reference 3-1.

3.3.1 Nondimensional Buckling Curves

Equation (10) of Sub-section 3.2 can be transformed to

$$\left(\frac{\bar{\sigma}_1}{\sigma_o}\right) \frac{1}{\frac{E_s}{E_A}\left[1 - \left\{\sqrt{6}\left(\frac{a_{10}}{r}\right)\left(1 - \frac{E_{To}}{E_{So}}\right)\right\}^{2/3}\right]} \tag{1}$$

$$= \frac{E_A}{\sigma_o}\ \frac{K r^2}{\ell^2} = \frac{E_A}{\sigma_o}\left(\frac{KI}{A\ell^2}\right) = \Phi$$

Utilizing the stress-strain relationship of Section 3 of Reference 3-1 $\left(\frac{E_A \epsilon}{\sigma_o} = (1 - \beta)\frac{\sigma}{\sigma_o} + \beta \sinh {}^{\sigma}/\sigma_o\right)$, it is possible to calculate values of E_s/E_A and E_T/E_s for various values of σ/σ_o and given in values of β. For a given value of the eccentricity ratio (a_{10}/r) it is then possible to calculate the value of Φ, which would result in a buckling stress ratio $(\bar{\sigma}_1/\sigma_o)$, by direct substitution in Eq. (1). This relationship is plotted in Figures 3.3.1-1 to -10 for a large range of eccentricity ratios. The argument Φ is a function of the material properties (E_A/σ_o) and the geometry and boundary conditions $(KI/A\ell^2)$. The shape of the stress-strain relationship is represented by the value of β. The method of obtaining the material parameters from a uniaxial test is presented in Section 3 of Reference 3-1. The determination of the initial eccentricity which may be caused by initial waviness, eccentric loads, lateral loading, and thermal gradients is discussed in Paragraph 3.3.2.

The graphs for small eccentricity ratios should result in fairly good agreement with experimental data since the approximations employed should be satisfactory. The graphs for large eccentricity ratios are less accurate and are expected to be unconservative.

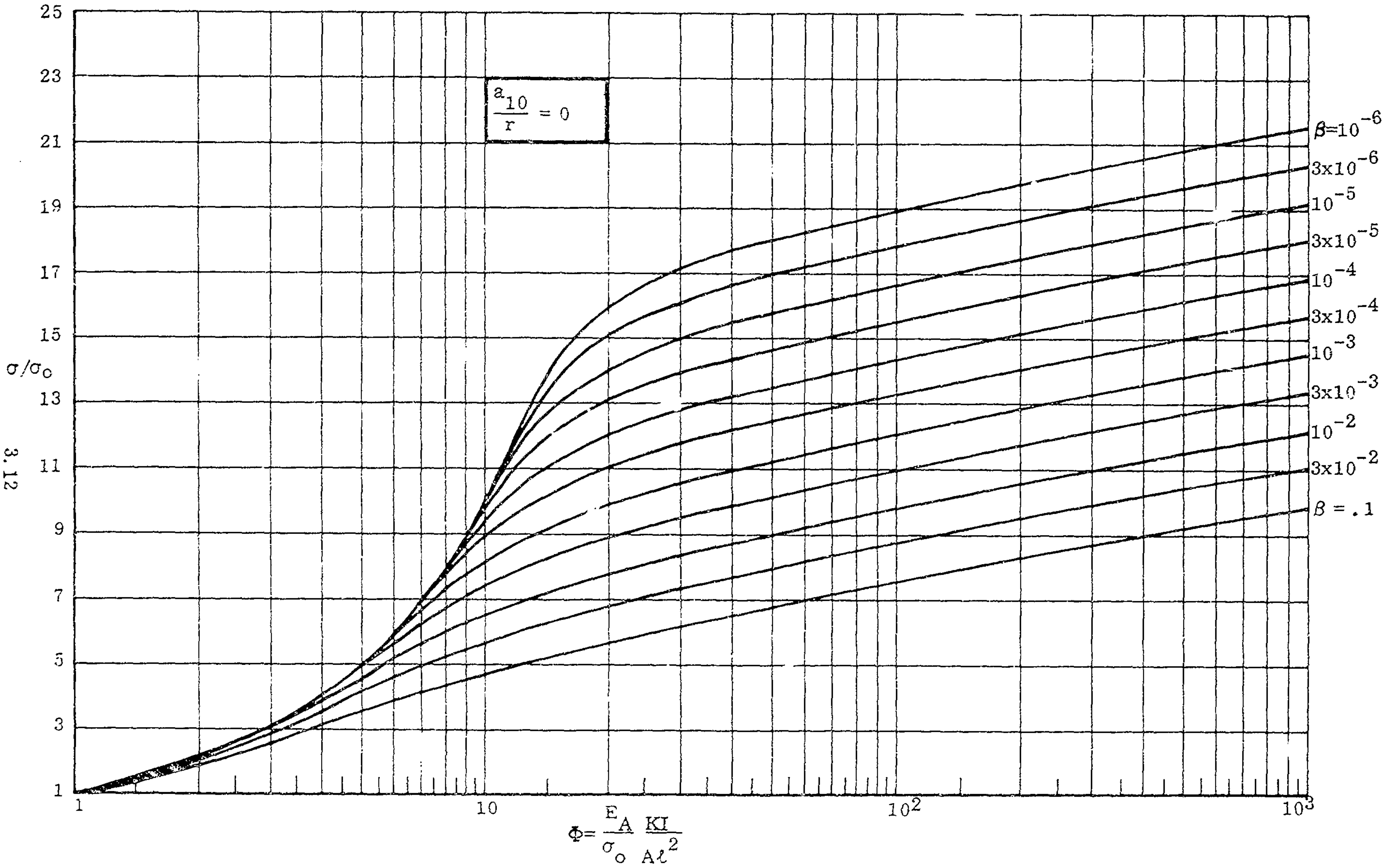


FIGURE 3.3.1-1 NON-DIMENSIONAL BUCKLING OF ECCENTRIC COLUMNS

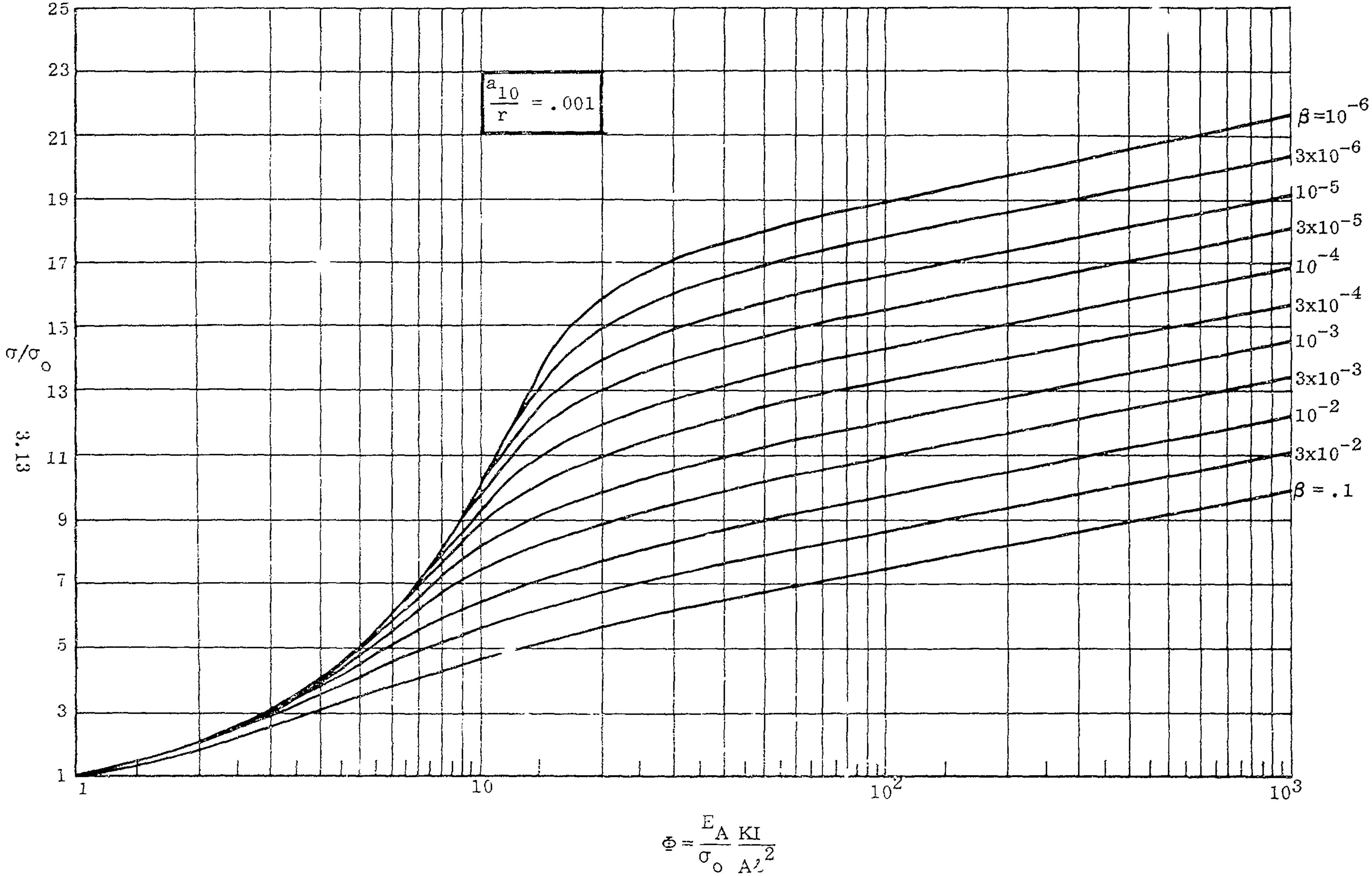


FIGURE 3.3.1-2 BUCKLING OF ECCENTRIC COLUMNS

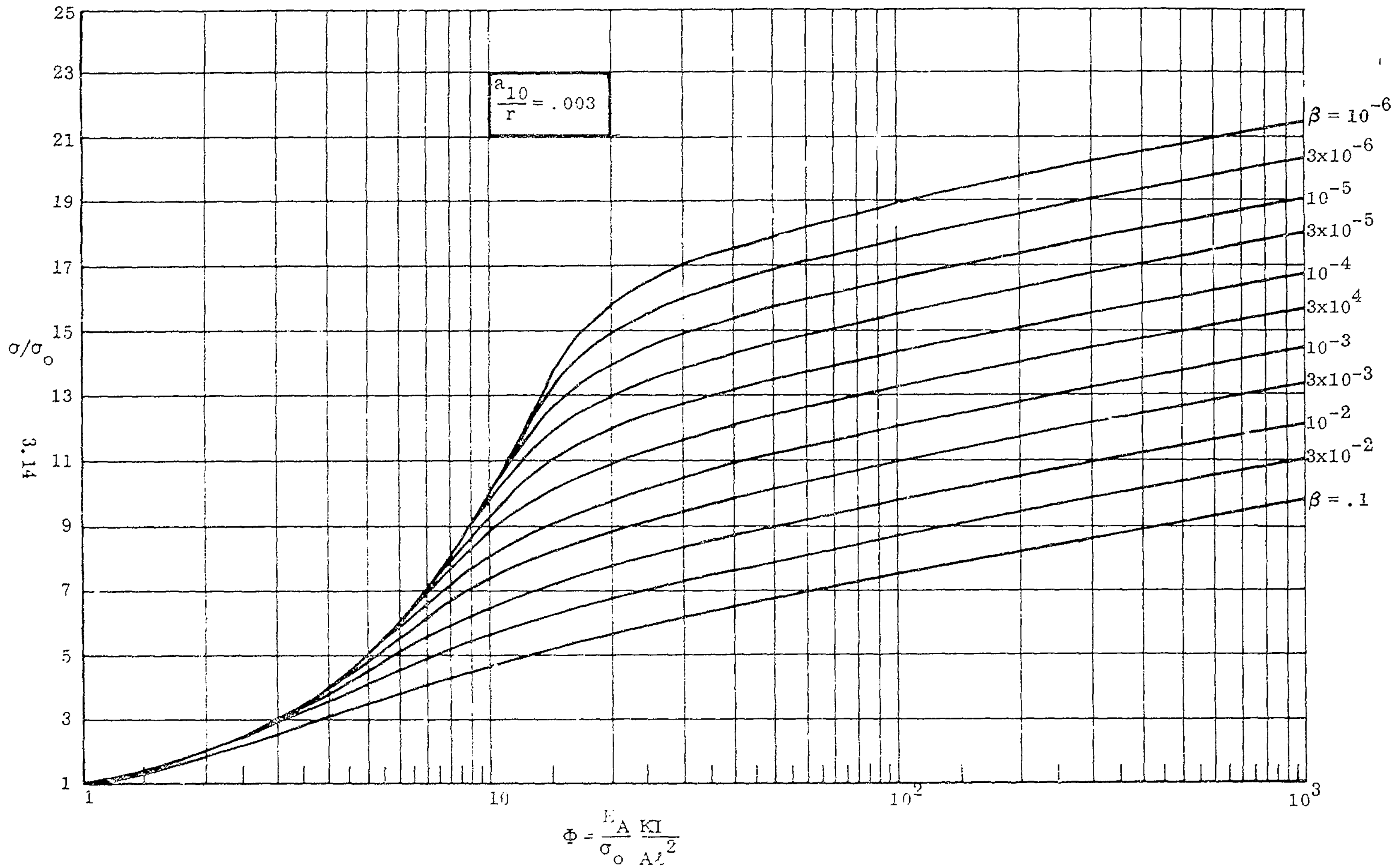


FIGURE 3.3.1-3 BUCKLING OF ECCENTRIC COLUMNS

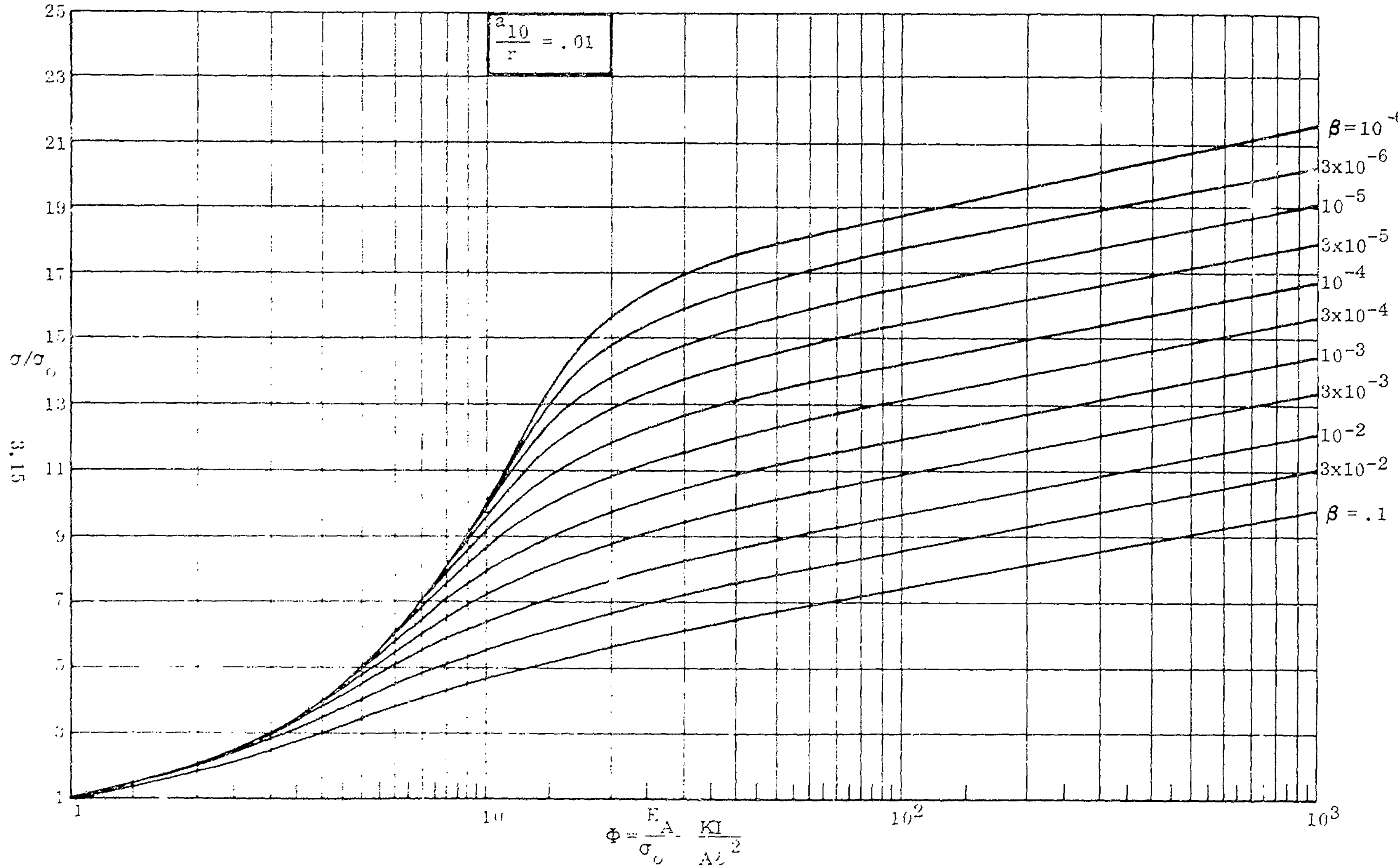


FIGURE 3.5.1-4 BUCKLING OF ECCENTRIC COLUMNS

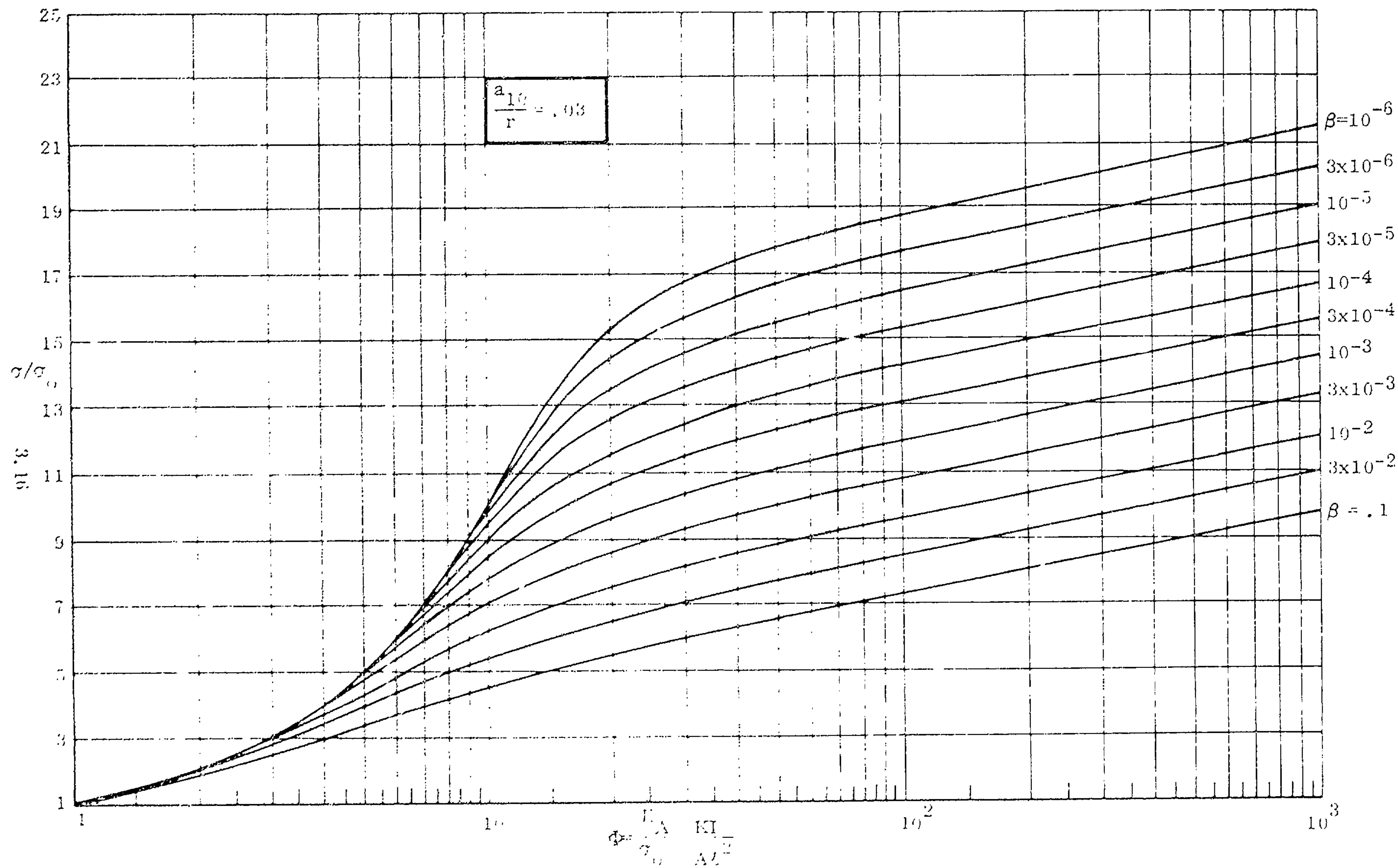


FIGURE 3.3.1-5 BUCKLING OF ECCENTRIC COLUMNS

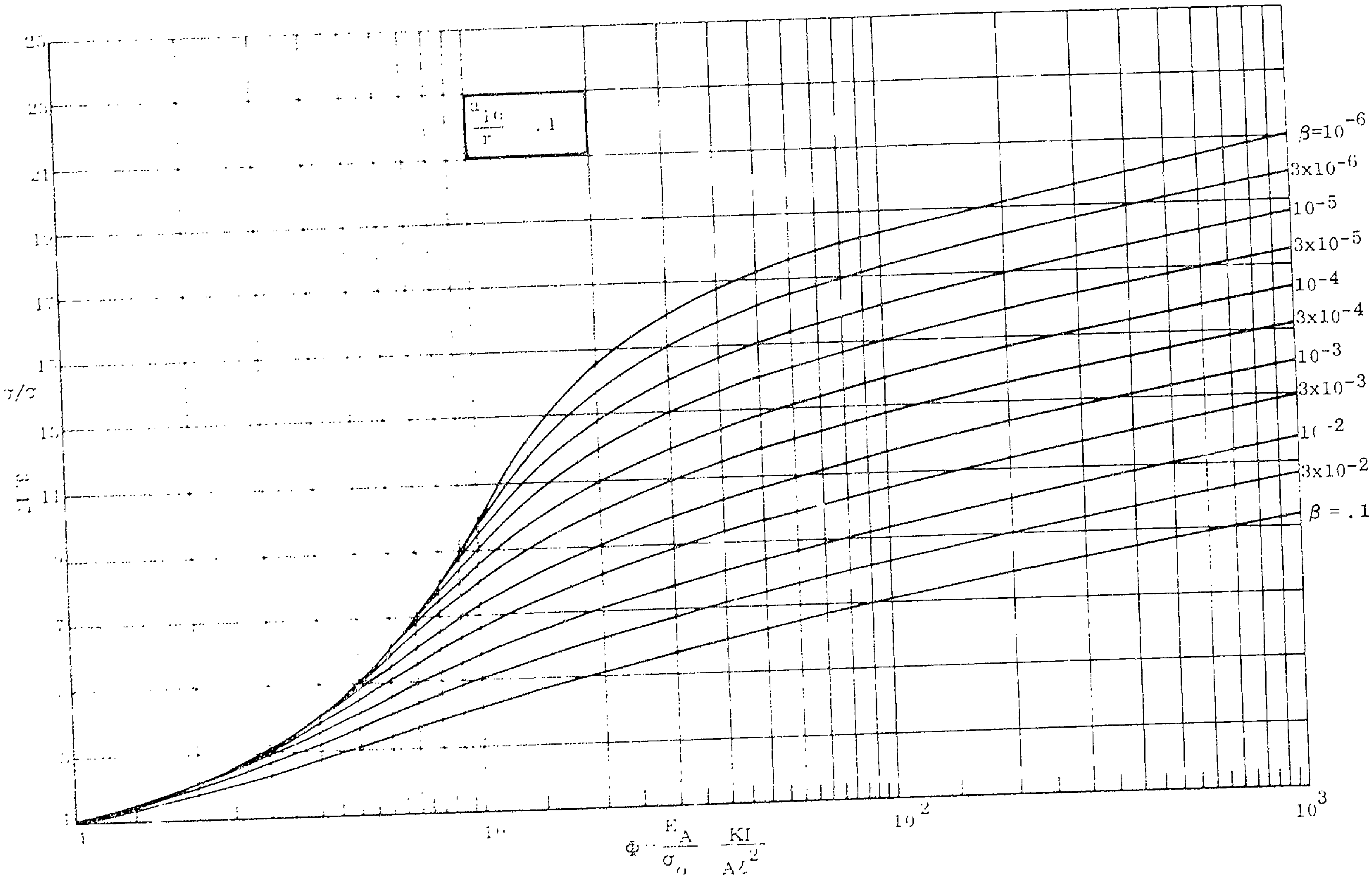


FIGURE 3.3.1-6 BUCKLING OF ECCENTRIC COLUMNS

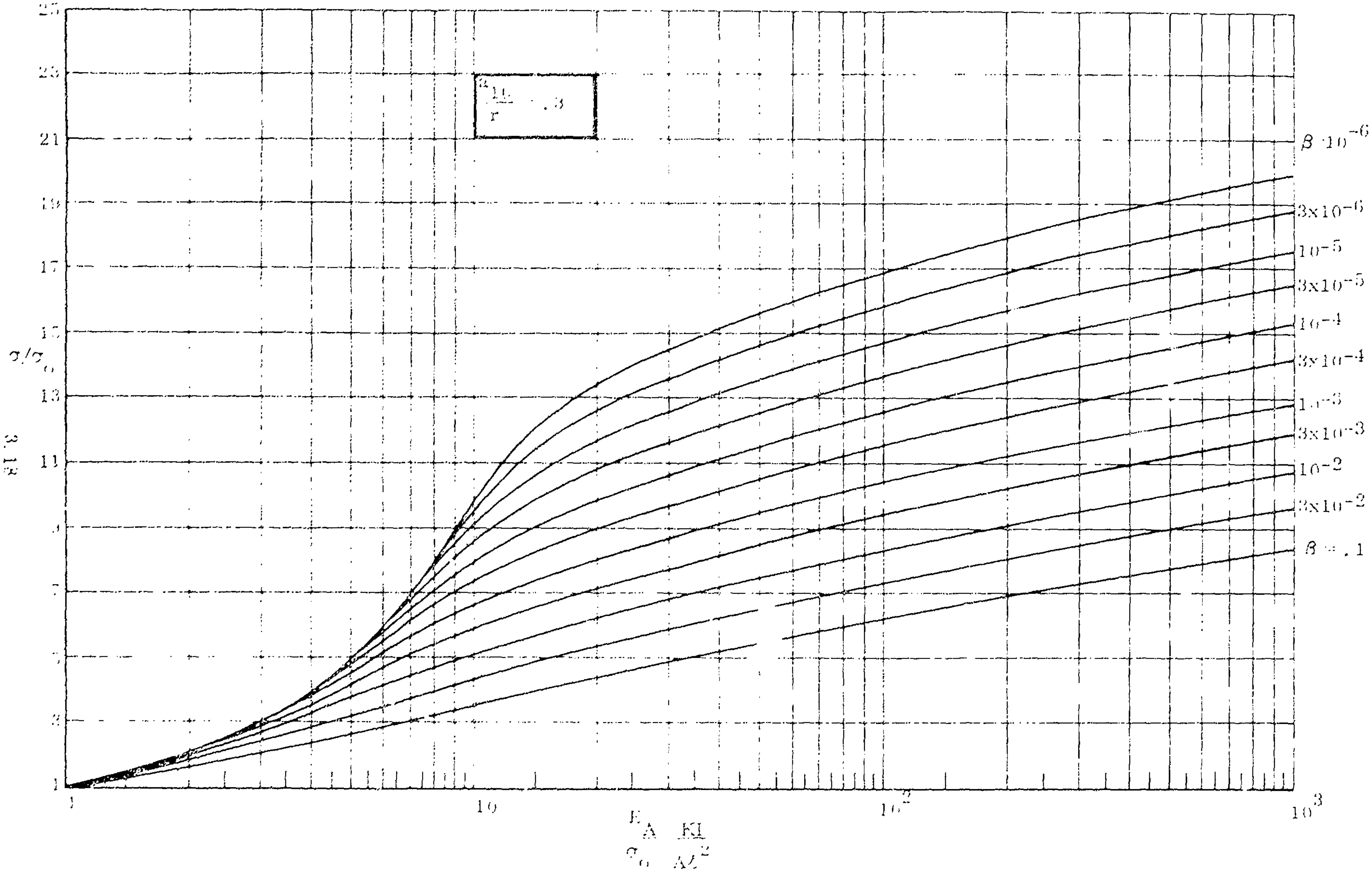


FIGURE 3.5.1.7 BUCKLING OF ECCENTRIC COLUMNS

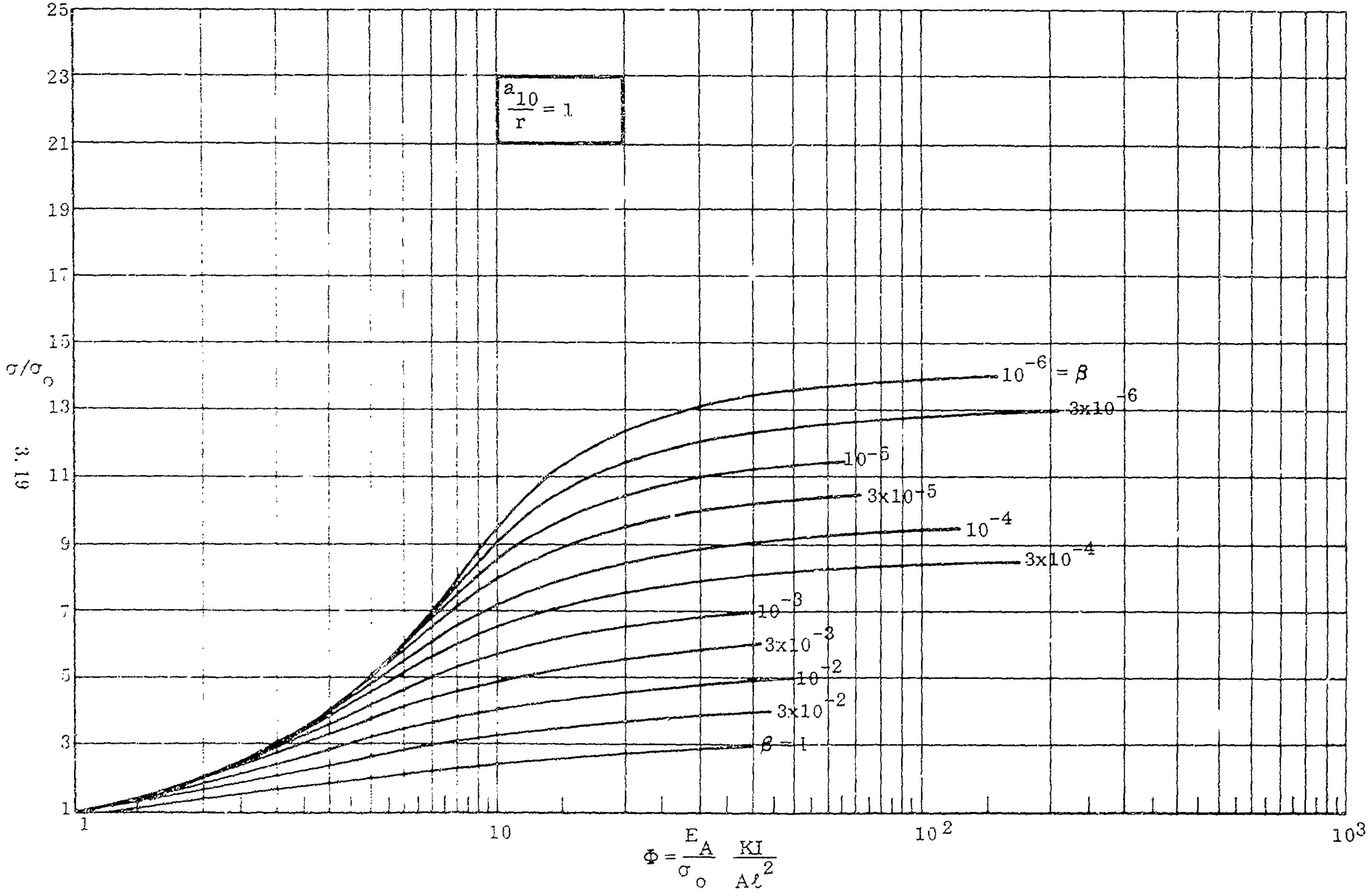


FIGURE 3.3.1-8 BUCKLING OF ECCENTRIC COLUMNS

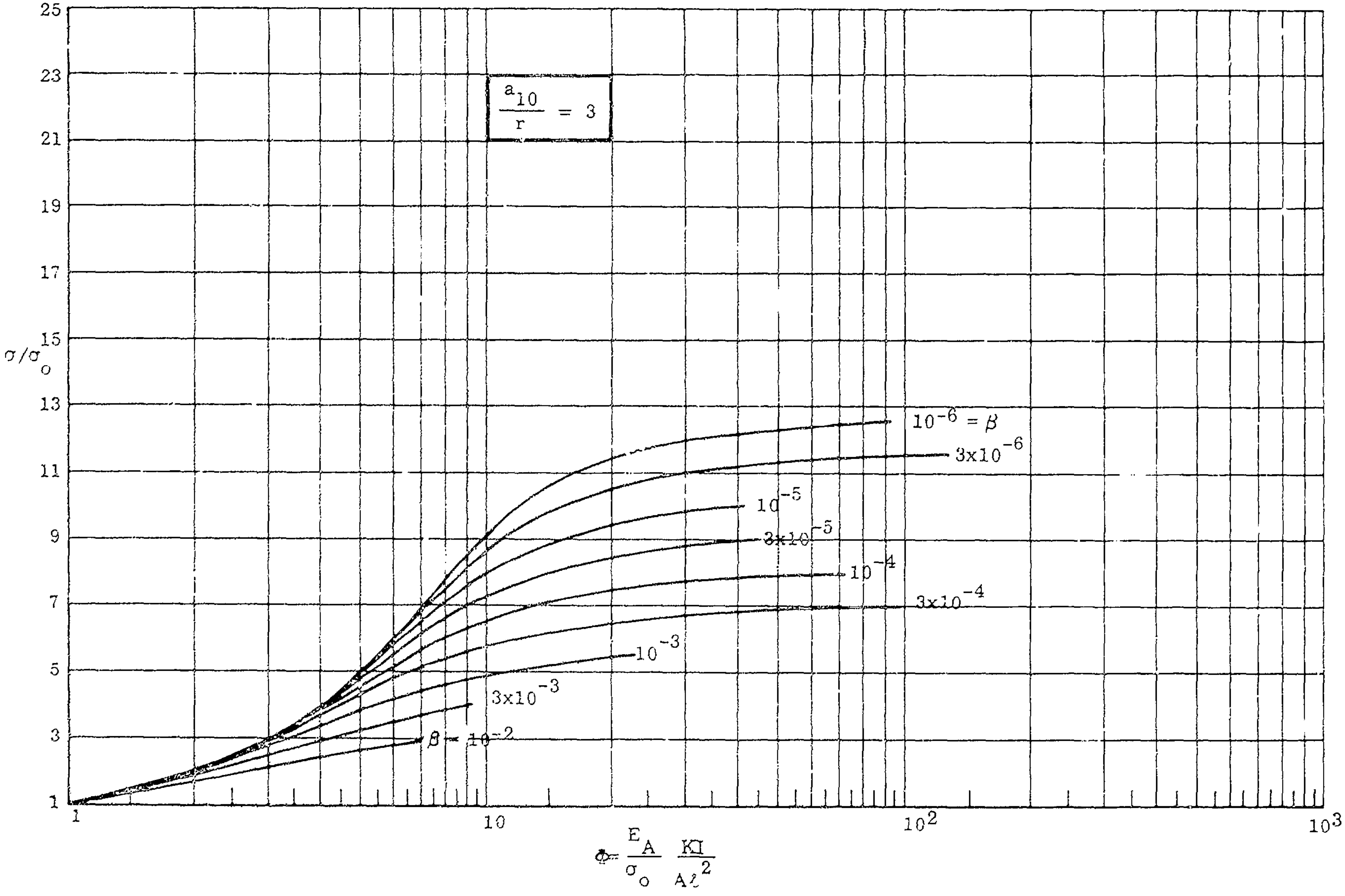


FIGURE 3.3.1-9 BUCKLING OF ECCENTRIC COLUMNS

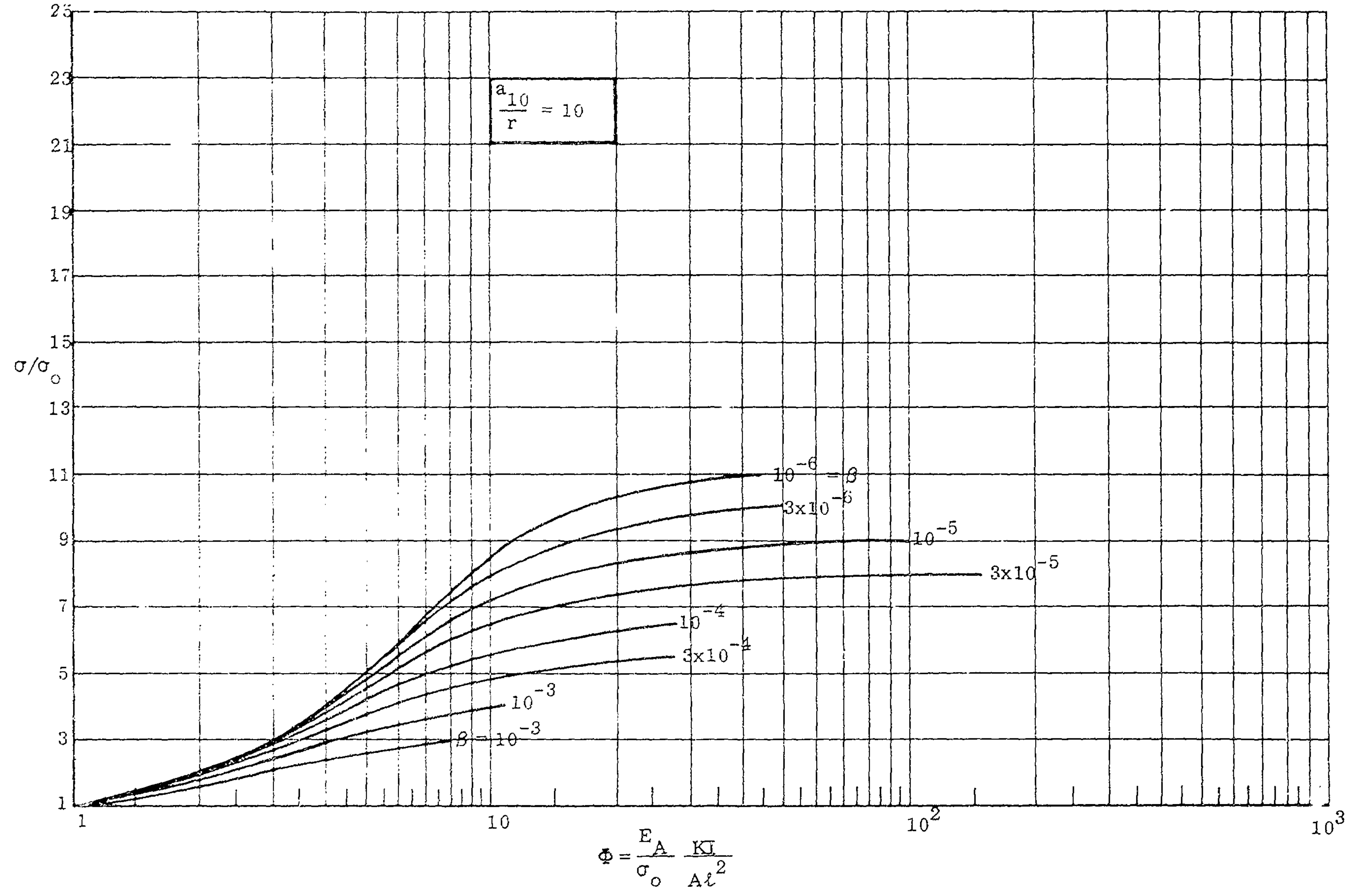


FIGURE 3.3.1-10 BUCKLING OF ECCENTRIC COLUMNS

3.3.2 Initial Eccentricity

The initial eccentricity must be evaluated in order to use the analysis curves.

Paragraph 2.3.3 indicated that the amplitude of the fundamental modes can be obtained by a weighted integration of the actual lateral deflection or by matching the deformation at discrete points.

Assuming that it is possible to express the initial eccentricity (w_o due to shape, axial load location, lateral loads and temperatures) as an analytical expression, it is possible to determine the magnitude of the first mode by utilizing the orthogonality between the lateral deflection and curvature (Eq. (2) of Paragraph 2.2.1),

Thus, if

$$w_o = \Sigma a_{io} w_i \tag{1a}$$

then from Eq. (2) of Paragraph 2.2.1 we obtain for constant bending stiffness ($\varphi = 1$)

$$a_{io} = \frac{\int_0^{\ell} w_o \varkappa_i \, dx}{\int_0^{\ell} w_i \varkappa_i \, dx} \tag{1b}$$

The following formulae are applicable to columns of constant bending stiffness

when

$$w_o = \Sigma m_j \xi^j \tag{2}$$

then for pin ends

$$a_{10} = 2 \Sigma m_j S(j, 1) \tag{3a}$$

while for clamped ends

$$a_{10} = 2 \Sigma m_j C(j, 1) \tag{3b}$$

when

$$\varkappa_T = \frac{1}{\ell^2} \Sigma m_j \xi^j \tag{4}$$

3.3.2 (Cont'd)

then for pin ends (Reference Eq. (3a) of Paragraph 2.3.3.1.1)

$$w_o = \Sigma \frac{m_j}{(j+1)(j+2)} \left(\xi^{j+2} - \xi\right) \tag{5a}$$

and

$$a_{10} = 2\,\Sigma \frac{m_j}{(j+1)(j+2)} \left[S(j+2,\ 1) - S(1,1)\right] \tag{6a}$$

while for clamped ends (Reference Eq. (4c) of Paragraph 2.3.3.1.1)

$$w_o = \Sigma \frac{m_j}{(j+2)(j+2)} \left(\xi^{j+2} - j\,\xi^3 - (1-j)\,\xi^2\right) \tag{5b}$$

and

$$a_{10} = 2\,\Sigma \frac{m_j}{(j+2)(j+1)} \left[C(j+2,\ 1) - j\,C(3,\ 1) - (1-j)\,C(2,\ 1)\right] \tag{6b}$$

Values of S(j, 1) and C(j, 1) are found in Tables 2.3.3.1.2-1 and -2 and are summarized in Table 3.3.2-1 below.

TABLE 3.3.2-1. FOURIER COEFFICIENTS FOR POLYNOMIALS

j	S(j, 1)	C(j, 1)
0	.6366	-
1	.3183	0
2	.1893	.05066
3	.1248	.07599
4	.08814	.08592
5	.06541	.08815
6	.05038	.08669

3.3.2 (Cont'd)

For a pinned end column of constant $\overline{EI}$ and constant linear thermal gradient

$$\varkappa_r = \frac{-\Delta \alpha T}{h} = \frac{m_o \xi^o}{\ell^2}$$ we obtain from Eqs.(5a) and (6a).

$$w_o = \frac{m_o}{(0+1)(0+2)} (\xi^{0+2} - \xi) = \frac{m_o}{2} (\xi^2 - \xi)$$

$$\therefore \quad w_o(\ell/2) = \frac{m_o}{2} (.5^2 - .5) = -\frac{m_o}{8} = \frac{\ell^2 \Delta \alpha T}{8h}$$

and

$$a_{10} = 2 \frac{m_o}{(1)(2)} \left[S(2,1) - S(1,1) \right]$$

$$\therefore \quad a_{10} = 2 \frac{m_o}{2} \left[.1893 - .3183 \right] = -.129 \, m_o = \frac{.129 \, \ell^2 \Delta \alpha T}{h} \tag{7}$$

A second method of obtaining the initial eccentricity is by matching the displacements at a discrete number of points. This requires the solution of the set of simultaneous equations $w_o(\xi) = \Sigma a_{io} w_i(\xi)$ for the value of a_{io} and is described in Paragraph 2.3.3.2. The approximation $a_{10} \approx w_o(1/2)$ is a solution where only one point, the deflection at the center of the column, was matched. The accuracy would increase with the number of displacements which are matched, although the matching of the center deflection of a pin ended column with a uniform lateral load or thermal gradient results in a satisfactory determination of the initial eccentricity. The accuracy also depends upon the form of the lateral deflection. For example, a matching of the mid-length deflection for a pin-ended column results in a more accurate amplitude of the fundamental mode caused by a uniform thermal gradient (parabolic) than by a constant eccentricity.

3.4 SPECIAL CASES

There exist special situations for which the exact solution is known or for which engineering approximations have been accepted because of experimental data. The plausibility of the approximate formulation, presented in this section, is reviewed by degenerating it to those situations with which the analyst has had some experience.

3.4.1 Linear Material

A material whose modulus is independent of the stress levels $\left(\frac{\partial E_s}{\partial \sigma} = 0, \quad E = E_T = E_S\right)$ is described as a linear material. The value of $(1 - E_{T\sigma}/E_{So})$ is identically zero and no reduction of bending stiffness occurs. The eccentricity (a_{10}/r) does not affect the stability and buckling occurs when the average axial strain attains a value of $K\left(\frac{r^2}{\ell^2}\right)$ (with the load equal to $F_E = \frac{K}{\ell^2} EI$) provided no fiber is stressed to its ultimate strength. This corresponds to the classical "Euler Column" whose buckling load and strain are well defined because of the linearity of the material beyond the buckling stress. A column with a large slenderness ratio (ℓ/r) would behave in the manner described. Although the nondimensional stress-strain relationship includes the linear case (letting $\beta = 0$), it is recommended that the actual value of β for the structural material be used even for the case of low buckling stresses. This will permit an approximation of the effects of eccentricities in causing extreme fiber stresses that may be beyond the "proportional limit" even when the average stress is very low. The deviation of the stability of a structure composed of material which is non-linear to a slight degree from that of a linear material will be insignificant for small eccentricities but may become significant for large eccentricities.

3.4.2 Perfectly Straight Columns

The perfectly straight column does not bend when subjected to an axial load. This condition is virtually impossible to attain experimentally but has some theoretical value as a mathematical model. The column will be stable as long as the axial strain remains below the critical strain $K \frac{r^2}{\ell^2}$ since a_{10} is zero. Any lateral excitation of the column below this value of the critical strain will dampen out whereas it will magnify and become excessively large when the critical strain is reached or exceeded by the column.

3.4.3 Small Initial Eccentricities

The effect of the eccentricity upon the stability of the column is small when the eccentricity ratio (a_{10}/r) is small. An upper bound upon the stability load will always be F_1 which corresponds to the employment of $E_{So} I_o$ as the effective buckling stiffness of the cross section and a critical strain of $K \; r^2/\ell^2$.

Under the conditions of continuous loadings $(E_{So} > E_{To})$ and small eccentricities $\left(1 >> \left(\frac{x_M z}{\epsilon_o}\right)^2\right)$, the lower bound of the stability load will be $F_1\left(\frac{E_{To}}{E_{So}}\right) = \frac{K}{\ell^2} E_{To} I_o$ which

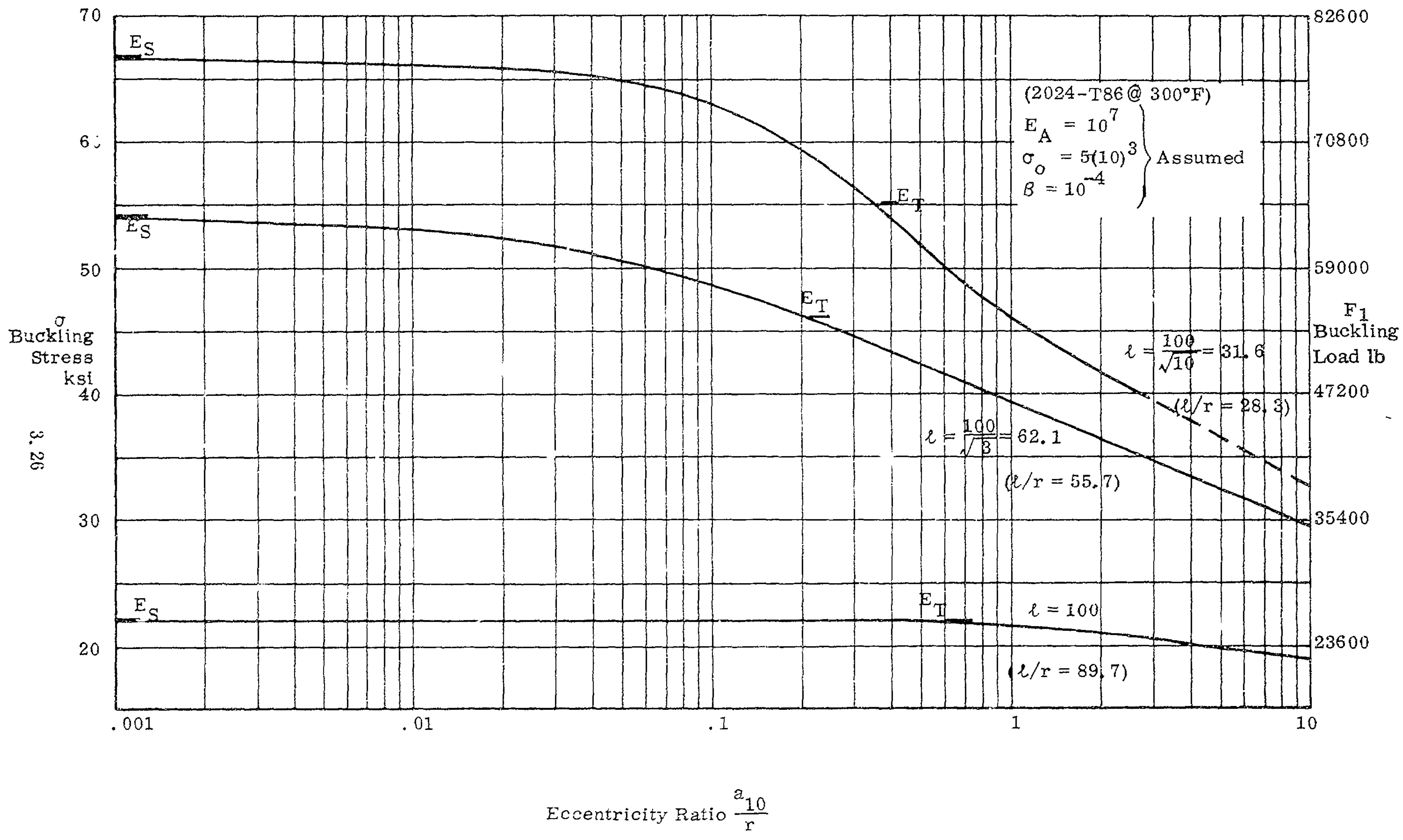


FIGURE 3.4.3-1 EFFECT OF ECCENTRICITY ON STABILITY

corresponds to the employment of $E_{To} I_o$ as the effective buckling stiffness of the cross section and a critical strain of $\left(\frac{E_{To}}{E_{So}}\right)\left(K \frac{r^2}{\ell^2}\right)$

This lower bound is satisfactory provided the eccentricity is not too large. The bending stresses become more significant in determining the bending stiffness as the eccentricity increases. An eccentricity ratio exists for each column beyond which the tangent modulus stability ceases to be a lower bound. This eccentricity ratio can be obtained by equating the tangent modulus load to the eccentric column load.

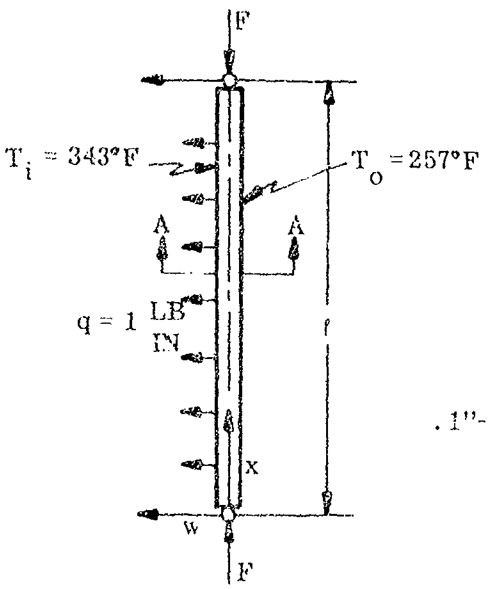
Equality results when $\frac{a_{10}}{r} = \sqrt{\frac{1 - E_{To}/E_{So}}{6}}$

A value of $(a_{10}/r$ less than $\sqrt{\frac{1 - E_{To}/E_{So}}{6}}$ results in a tangent modulus load that is conservative with respect to the eccentric column load (i.e., $E_{To} I_o \leq \overline{\overline{EI}}$) whereas a larger eccentricity ratio will make the tangent modulus load unconservative. The value of the critical eccentricity ratio depends upon the material and the slenderness ratio of the column. This is illustrated in Figure 3.4.3-1 which indicates the effect of eccentricity on the stability of the columns described in the illustrative problems. The tangent modulus loads stops being conservative for eccentrivity ratios between .2 and .5 for the columns analyzed, and the critical eccentricity ratios are indicated in Figure 3.4.3-1.

3.5 ILLUSTRATIVE PROBLEMS

The computational techniques are illustrated in the following problems:

Find the buckling loads of the following pin ended columns of constant cross section illustrated in Figure 3.5-1.



a) ℓ = 100" (Slender column)
b) ℓ = $100/\sqrt{3} = 62.1"$ (Intermediate column)
c) ℓ = $100/\sqrt{10} = 31.6"$ (Short column)

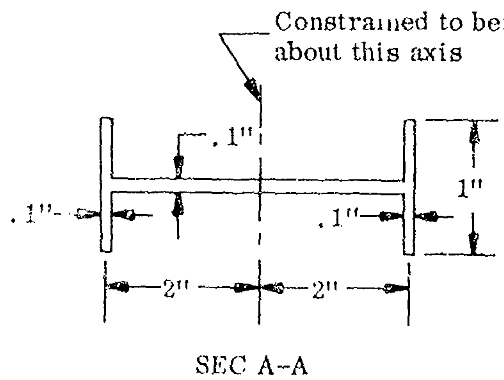


FIGURE 3.5-1 COLUMN SUBJECTED TO LOAD AND TEMPERATURE

3.5 (Cont'd)

The temperature is assumed constant on each face of the column with a linear gradient through the thickness. Material parameters are assumed for 2024-T86 at the mean temperature of 300°F to illustrate the computational technique. The actual values must be determined from standard material tests.

Material Properties

The following material properties are assumed:

$$\alpha = 12(10)^{-6} \text{ in/in/°F}$$

$$E_A = 10^7 \text{ psi}$$

$$\sigma_o = 5000 \text{ psi}$$

$$\beta = 10^{-4}$$

Initial Geometry

$$A = 0.1\,(1.0 + 3.9 + 1.0) = .59 \text{ in}^2$$

$$I_o = 2(.1)(2)^2 + \frac{1}{12}(.1)(3.9)^3 = 1.30 \text{ in}^4$$

$$r^2 = I_o/A = 2.2 \text{ in}^2$$

$$r = 1.15 \text{ in}$$

$$\Phi = \frac{E_A}{\sigma_o}\frac{KI}{A\ell^2} = \frac{E_A}{\sigma_o} K \frac{r^2}{\ell^2} = \frac{10^7}{5(10)^3}\pi^2\frac{2.2}{\ell^2} = \frac{4.4}{(\ell/100)^2}$$

$$\epsilon_1 = K\frac{r^2}{\ell^2} = \pi^2\frac{2.2}{\ell^2} = \frac{22}{\ell^2}$$

Initial Eccentricity

Because the temperature distribution is linear through the thickness we can utilize Eq. (4) of Paragraph 3.3.2.

$$(a_{10})_T = .129\,\frac{\Delta\alpha T}{h}\,\ell^2 = .129\,\frac{\alpha(T_i - T_o)}{h}\,\ell^2 \qquad (1)$$

$$\therefore \quad \frac{(a_{10})_T}{r} = \frac{.129\,\alpha\,(T_i - T_o)\,\ell^2}{r\,h} = \frac{.129(12)(10)^{-6}\,(343-257)}{(1.15)(4.1)} = .28\left(\frac{\ell}{100}\right)^2$$

3.5 (Cont'd)

From standard reference texts the lateral deflection due to a uniform load q is

$$(w_o)_q = \frac{q\ell^4}{24\,EI}\,(\xi - 2\xi^2 + \xi^4)$$

From Eq. (3a) of Paragraph 3.3.2

$$(a_{10})_q = 2\,\frac{q\ell^4}{24\,EI}\left[S(1,1) - 2S(2,1) + S(4,1)\right]$$

From Table 3.3.2-1

$$(a_{10})_q = 2\,\frac{q\ell^4}{24\,EI}\left[.318.. - 2(.1248) + (.08814)\right] = .013066\,\frac{q\ell^4}{EI} \qquad (2)$$

$$\therefore \quad \frac{(a_{10})_q}{r} = \frac{.013066\,(1)\,\ell^4}{(10)^7\,(1.3)(1.15)} = .08\left(\frac{\ell}{100}\right)^4$$

It should be noted that

$$(w_o)_q\ (\text{at } x = \ell/2) = \frac{5}{384}\,\frac{q\ell^4}{EI} = .01302\,\frac{q\ell^4}{EI} \approx .013066\,\frac{q\ell^4}{EI} = (a_{10})_q$$

and

$$(w_o)_T\ (\text{at } x = \ell/2) = .125\,\frac{\Delta\alpha T}{h}\ell^2 \approx .129\,\frac{\Delta\alpha T}{h}\ell^2 = (a_{10})_T$$

This indicates the magnitude of the errors which can be introduced by approximating the amplitude of the fundamental mode by the deflection at the center of the column are quite small for a pin ended column subjected to uniform lateral load or thermal gradient.

The initial eccentricity ratio is then calculated as follows:

$$\left(\frac{a_{10}}{r}\right) = \frac{(a_{10})_T}{r} + \frac{(a_{10})_q}{r} = .28\left(\frac{\ell}{100}\right)^2 + .08\left(\frac{\ell}{100}\right)^4$$

For

$$\ell = 100 \quad ; \quad \frac{a_{10}}{r} = .28 + .08 = .36$$

$$\ell = 100/\sqrt{3} \quad ; \quad \frac{a_{10}}{r} = .093 + .008 = .101$$

$$\ell = 100/\sqrt{10} \quad ; \quad \frac{a_{10}}{r} = .028 + .0008 = .0288$$

3.5 (Cont'd)

Stability

Referring to the appropriate graph of Figures 3.3.1 results in the determination of $(\bar{\sigma}_1/\sigma_o)$ for the given values of β, Φ, and (a_{10}/r). The effect of the eccentricity, which is expressed in Eq. (11d) of Paragraph 3.2, can be evaluated by comparing the given value of Φ to the value $\bar{\Phi}$ which corresponds to $(\bar{\sigma}_1/\sigma_o)$ for a straight column (Figure 3.3.1-1 with $a_{10/r} = 0$). This value of $\bar{\Phi} = \frac{E_A}{\sigma_o}\bar{\epsilon}_1$, corresponds to a material and geometry parameter for a straight column which would buckle at the same stress as the eccentric column and is a measure of the average axial strain in the column.

a) For $\ell = 100$, $E_A = 10^7$, $\sigma_o = 5000$, and $\beta = .0001$ we obtain $\Phi = 4.4$, $\epsilon_1 = .0022$, and $\frac{a_{10}}{r} = .36$.

From Figures 3.3.1-7 and -8

$$\frac{\bar{\sigma}_1}{\sigma_o} = 4.4$$

$$\bar{\sigma}_1 = 4.4(5000) = 22000 \text{ psi}$$

$$\bar{F}_1 = \bar{\sigma}_1 A = 22000(.59) = 13000\#$$

From Figure 3.3.1-1

$$\bar{\Phi} = 4.4$$

$\bar{\Phi}/\Phi = 4.4/4.4 = 1$ (no effect of eccentricity because of the large slenderness ratio)

and

$$\bar{\epsilon}_1 = \epsilon_1\left(\bar{\Phi}/\Phi\right) = .0022$$

b) Similarly for $\ell = 100/\sqrt{3}$

$\Phi = 13.2$, $\epsilon_1 = .0066$, and $\frac{a_{10}}{r} = .101$

From Figure 3.3.1-6

$$\frac{\bar{\sigma}_1}{\sigma_o} = 9.7$$

$$\bar{\sigma}_1 = 9.7(5000) = 48500 \text{ psi}$$

$$\bar{F}_1 = 48500(.59) = 28500\#$$

3.5 (Cont'd)

and from Figure 3.1.1-1

$$\bar{\Phi} = 10.5 \qquad \bar{\Phi}/\Phi = \frac{10.5}{13.2} = .80$$

$$\therefore \quad \bar{\epsilon}_1 = .0066(.80) = .0053$$

c) For $\ell = 100/\sqrt{10}$

$$\Phi = 44, \quad \epsilon_1 = .022, \text{ and } \frac{a_{10}}{r} = .0288$$

$$\therefore \quad \bar{\sigma}_1/\sigma_o = 13.1$$

$$\bar{\sigma}_1 = 13.1(5000) = 65500 \text{ psi}$$

$$\bar{F}_1 = 65500(.59) = 38500\#$$

$$\bar{\Phi} = 38 \qquad \bar{\Phi}/\Phi = 38/44 = .87$$

$$\bar{\epsilon}_1 = .022(.87) = .019$$

The eccentricity ratios a_{10}/r were sufficiently close to available values that there was no need to interpolate between graphs. Plots can be made to show the variation in the stability of a given column with the initial eccentricity and can be utilized if interpolation is required. These plots are shown in Figure 3.4.3-1 for the three (long, intermediate and short) columns analyzed above. The values corresponding to an effective modulus of E_S are obtained from Figure 3.3.1-1 $\left(\frac{a_{10}}{r} = 0\right)$ and the values corresponding to an effective modulus of E_T are obtained from Figure 9.2.1-2 of Reference 3-1. The plots indicate that $\overline{\overline{EI}} = E_{So}I_o$ is always unconservative and $\overline{\overline{EI}} = E_{To}I_o$ becomes unconservative in the vicinity of $.2 \le \frac{a_{10}}{r} \le .5$ for the analyzed columns. It should be noted that the reduction in the stability of the long column is least while the reduction in the stability of the intermediate column is greatest with the short column affected to an intermediate degree. This is because the reduction in the stability of the eccentric column depends both upon the eccentricity and the stress levels attained by the column. The long column has the largest eccentricity ratio but has very low axial stresses, the short column has very high axial stresses but very small eccentricities; while the intermediate column has high stresses and moderately high eccentricities.

It is interesting to note the contributions of the various factors in reducing the stability of the column below the "Euler Load" $\left(F_E = \frac{KEI_o}{\ell^2}\right)$. The factors reducing the stability stiffness can be roughly divided into two parts. The first part represents the reduction in the axial stiffness due to the plasticity caused by average stresses which are above the proportional limit of the material. The second part represents additional reductions in

3.5 (Cont'd)

the stability stiffness because of the eccentricity causing a shift in the neutral axis and a rate of change of the bending stiffness.

Equation (2b) of Paragraph 3.2 can be transformed to the following approximate form in order to evaluate quantitatively the destabilizing effects of eccentricity and plasticity.

$$\frac{\bar{F}_1}{F_E} = \frac{E_{So}I_o}{EI_o}\left(\frac{\overline{EI}}{E_{So}I_o} + \frac{x}{E_{So}I_o}\frac{\partial \overline{EI}}{\partial x}\right) \approx \left(\frac{E_{So}I_o}{EI_o}\right)\left(\frac{\overline{EI}}{E_{So}I_o}\right)\left(1 - \frac{x}{E_{So}I_o}\frac{\partial \overline{EI}}{\partial x}\right)$$

where

$\bar{F}_1$	is the buckling load of the eccentric column
F_E	is the Euler buckling load
$\frac{E_{So}I_o}{EI_o}$	is the factor representing the reduction in axial stiffness
$\overline{EI}/E_{So}I_o$	is the effect of the shifting of the neutral axis
$\left(1 - \frac{x}{E_{So}I_o}\frac{\partial \overline{EI}}{\partial x}\right)$	is the effect due to the change in the bending stiffness

The numerical calculations for the destabilizing effects are summarized in Table 3.5-1.

TABLE 3.5-1 STABILITY RATIOS

DESTABILIZING PHENOMENON	LENGTH OF COLUMN		
	$\ell = 100''$	$\ell = 100/\sqrt{3}$	$\ell = 100/\sqrt{10}$
Reduction in Axial Stiffness			
(Plasticity Effect)			
$\frac{E_{So} I_o}{E I_o} = \frac{F_1}{F_E}$	1.00	.73	.30
Further Reductions in Stability Stiffness			
(Eccentricity Effects)			
a) Shift of Neutral Axis			
$\frac{\overline{EI}}{E_{So} I_o} = 1 - 2\alpha^2 r^2$	1.00	.93	.955
b) Rate of Change of Bending Stiffness			
$1 - \frac{\chi}{E_{So} I_o} \frac{\partial EI}{\partial \chi} = 1 - 4\alpha^2 r^2$	1.00	.87	.91
c) Critical Strain Ratio-Total Eccentricity Effect			
$\frac{\bar{\epsilon}_1}{\epsilon_1} = 1 - 6\alpha^2 r^2 = \frac{\bar{F}_1}{F_1}$	1.00	.80	.865
Stability Stiffness Reduction			
$\frac{\bar{F}_1}{F_E} = \frac{\bar{F}_1}{F_1} \frac{F_1}{F_E}$	1.00	.58	.26

3.6 REFERENCES

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SECTION 4

AXISYMMETRIC LARGE DEFLECTIONS OF CIRCULAR PLATES SUBJECTED TO THERMAL AND MECHANICAL LOADS

by

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SECTION 4

AXISYMMETRIC LARGE DEFLECTIONS OF CIRCULAR PLATES SUBJECTED TO THERMAL AND MECHANICAL LOADS

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SECTION 4 - AXISYMMETRIC LARGE DEFLECTIONS OF CIRCULAR PLATES SUBJECTED TO THERMAL AND MECHANICAL LOADS

4.1 SUMMARY

This report is concerned with the nonlinear axisymmetric analysis of circular plates with in-plane edge restraint Both temperature and mechanical loads are accomodated as an extension of investigations performed for the isothermal mechanical loading problem (References 4-1 through 4-4). An exact mathematical formulation within the framework of the v. Karman large strain-displacement relations (Reference 4-5) is developed. The equilibrium equations and boundary conditions are then derived by utilizing the calculus of variations for arbitrary axisymmetrical temperatures and normal distributed loading. The satisfaction of equilibrium and compatibility equations requires the solution of two simultaneous nonlinear ordinary differential equations subject to the prescribed boundary conditions. Analytical solutions of such equations are apparently not possible and therefore numerical procedures must be employed.

A finite difference procedure utilizing "relaxed iterations," developed by H. Keller and E. Reiss (Reference 4-4), and employed by them for the solution of isothermal problems with apparently unlimited load parameter ranges, is used here for combined thermo-mechanical problems. Numerical results are presented for the special case of a simply supported circular plate with radially immovable boundaries, subject to a uniform pressure and an arbitrary temperature variation through the thickness (no planform variation). These results have been obtained for a large range of temperature and load parameters. However, because of space limitations, only a limited amount of data is presented in this report.

4.2 INTRODUCTION

One of the basic assumptions of the classical linear theory of plates is that bending action does not induce significant midplane stretching. It is further assumed that stresses and deformations produced by loads and restraints in the midplane are superposible on the bending solution. Thus, coupling between the two effects is not accommodated by the classical theory. When the deflections are not small compared to the plate thickness, midplane stretching is no longer insignificant, resulting in a nonlinear interaction between bending and membrane stresses. Therefore, large deflection theory must be employed.

It is the purpose of this report to investigate the axisymmetric large deflection problem for circular plates.

The general formulation presented considers arbitrary axisymmetric temperature and pressure variation, where the von Karman large strain-displacement relations (Reference 4-5) are utilized. These assume infinitesimal strains and finite but small normal deflections ($(\frac{dw}{dr})^2$ is of the order of the strains, but small compared to unity). The remaining assumptions are those of classical plate theory. This formulation is more complete than the conventional linear theory in that the results are valid for deflection magnitudes several times the plate thickness. Moreover, buckling and postbuckling behavior are embodied in the analysis.

Numerical results in nondimensional tabular and graphical form are given for a simply supported circular plate, with full boundary restraint to radial movement, subjected to uniform pressure and arbitrary temperature variation through the thickness.

The following symbols are used throughout this section:

b	Plate radius
h	Plate thickness
r	Radial coordinate
$\bar{r}$	$\frac{r}{b}$, nondimensional radial coordinate
u	Midplane radial displacement
u_b	Midplane radial displacement at plate edge
u^*	Radial displacement
w	Normal deflection
$\bar{w}$	$\frac{w}{h}$, nondimensional normal deflection
z	Thickness coordinate
D	$\frac{Eh^3}{12(1-\nu^2)}$, flexural rigidity
E	Young's modulus
K	Relaxation parameter
M_r, M_t	Radial and tangential bending moments, respectively
$\bar{M}_r, \bar{M}_t$	Nondimensional radial and tangential bending moments, respectively
M_T	$\int_{-h/2}^{h/2} E\alpha Tz\,dz$
$\bar{M}_T$	Nondimensional form of M_T
N_r, N_t	Radial and tangential membrane forces, respectively
$\bar{N}_r, \bar{N}_t$	Nondimensional radial and tangential membrane forces, respectively

4.2 (Cont'd)

N_T	$\int_{-h/2}^{h/2} E\alpha T dz$
$\bar{N}_T$	Nondimensional form of N_T
q	Normal pressure
Q	Nondimensional normal pressure
T	Local temperature with respect to an unstressed and undeflected datum
U_o	Strain energy density
V	Total potential energy
α	Coefficient of linear thermal expansion
β	Slope
ϵ_r, ϵ_t	Radial and tangential strains, respectively
$\epsilon_r^o, \epsilon_t^o$	Midplane radial and tangential strains, respectively
λ	Elastic in-plane edge restraint
ν	Poisson's ratio
ϕ	$\frac{\psi b}{D}$, nondimensional stress function
ϕ_i	Finite difference value of ϕ at the i'th grid point
ψ	Stress function
σ_r, σ_t	Radial and tangential stresses, respectively
θ	$\frac{b}{h}\sqrt{6(1-\nu^2)}\ \beta$
θ_i	Finite difference value of θ at the i'th grid point

4.3 BASIC EQUATIONS

4.3.1 Stress-Strain - Displacement Relations

The von Kármán large strain - displacement relations for the axisymmetric strains at any point in the plate are given by

$$\epsilon_r = \frac{du^*}{dr} + \frac{1}{2}\left(\frac{dw}{dr}\right)^2 \qquad \epsilon_t = \frac{u^*}{r} \tag{1}$$

where $u^*(r,z)$ is the radial displacement of the point and $w(r)$ is the deflection normal to the undeflected midplane (Figure 4.3.1-1).

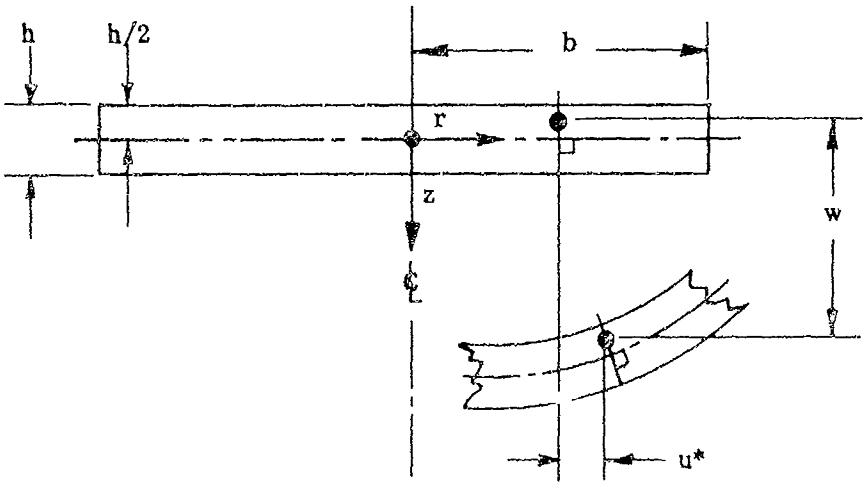


FIGURE 4.3.1-1 GENERAL AXISYMMETRIC DEFLECTION OF A TYPICAL POINT IN THE PLATE

Assuming plane sections to remain plane and normal to the deflected middle surface,

$$u^* = u - z\,\frac{dw}{dr} \tag{2}$$

where $u = u(r)$ is the radial displacement of the midplane. From (1) and (2),

$$\epsilon_r = \frac{du}{dr} - z\frac{d^2w}{dr^2} + \frac{1}{2}\left(\frac{dw}{dr}\right)^2 \qquad (3)$$

$$\epsilon_t = \frac{u}{r} - \frac{z}{r}\frac{dw}{dr}$$

The last (nonlinear) term in the first of (3) does not appear in the conventional small deflection theory. From Hooke's law (neglecting normal stresses in the thickness direction), including the temperature "T", there results

$$\sigma_r = \frac{E}{1-\nu^2}\left[\epsilon_r + \nu\epsilon_t - (1+\nu)\alpha T\right] \qquad (4)$$

$$\sigma_t = \frac{E}{1-\nu^2}\left[\epsilon_t + \nu\epsilon_r - (1+\nu)\alpha T\right]$$

An integration of (4) through the plate thickness yields†

$$N_r = \int_{-h/2}^{h/2} \sigma_r\,dz = \frac{Eh}{1-\nu^2}\left[\epsilon_r^o + \nu\epsilon_t^o - \frac{(1+\nu)}{Eh}N_T\right] \qquad (4a)$$

$$N_t \int_{-h/2}^{h/2} \sigma_t\,dz = \frac{Eh}{1-\nu^2}\left[\epsilon_t^o + \nu\epsilon_r^o - \frac{(1+\nu)}{Eh}N_T\right]$$

where the midplane strains are given by

$$\epsilon_r^o = \frac{du}{dr} + \frac{1}{2}\left(\frac{dw}{dr}\right)^2 \qquad (4b)$$

$$\epsilon_t^o = \frac{u}{r}\,,$$

† In what follows, it is assumed that $\alpha T = \alpha T(r,z)$ but that E (and hence D) is constant.

and

$$N_T = \int_{-h/2}^{h/2} E\alpha T\,dz \quad . \tag{4c}$$

Multiplying (4) by z and then integrating through the thickness yields

$$M_r = \int_{-h/2}^{h/2} \sigma_r z\,dz = -D\left[\frac{d^2w}{dr^2} + \frac{\nu}{r}\frac{dw}{dr} + \frac{M_T}{D(1-\nu)}\right]$$

$$M_t = \int_{-h/2}^{h/2} \sigma_t z\,dz = -D\left[\frac{1}{r}\frac{dw}{dr} + \nu\frac{d^2w}{dr^2} + \frac{M_T}{D(1-\nu)}\right] \tag{4d}$$

where

$$M_T = \int_{-h/2}^{h/2} E\alpha T z\,dz \tag{4e}$$

and

$$D = \frac{Eh^3}{12(1-\nu^2)}$$

4.3.2 Strain and Potential Energies

The strain energy per unit of volume is given by (Reference 4-6):

$$U_o = \frac{1}{2}\left[\epsilon_r\sigma_r + \epsilon_t\sigma_t - \alpha T(\sigma_r + \sigma_t)\right] \tag{1}$$

Substitution of the stress-strain relations (4) of Paragraph 4.3.1 into (1) yields

$$U_o = \frac{E}{2(1-\nu^2)}\left[\epsilon_r^2 + \epsilon_t^2 + 2\nu\epsilon_r\epsilon_t - 2(1+\nu)(\epsilon_r + \epsilon_t)\alpha T + 2(1+\nu)(\alpha T)^2\right] \tag{2}$$

For rotationally workless restraints at the outer boundary, the total potential of the plate and external loading system is given by the following equation:

4.3.2 (Cont'd)

$$V = 2\pi\int_0^b r\int_{-h/2}^{h/2} U_o\,dz\,dr - 2\pi\int_0^b q\,w\,r\,dr + \pi b\lambda u_b^2 \tag{3}$$

where q is the normal pressure, λ is an elastic restraint per unit circumferential length to radial displacement of the boundary, and $u_b = u]_{r=b}$. From Eqs. (3) of Paragraph 4.3.1, and (2) and (3) the potential energy in terms of the displacement components and temperature becomes

$$\begin{aligned} V = \frac{\pi E}{1-\nu^2}\int_0^b r\Bigg[\Bigg\{&\left[\frac{du}{dr}+\frac{1}{2}\left(\frac{dw}{dr}\right)^2\right]^2 + \left(\frac{u}{r}\right)^2 + \frac{2\nu u}{r}\left[\frac{du}{dr}+\frac{1}{2}\left(\frac{dw}{dr}\right)^2\right]\Bigg\}h \\ &+\left\{\left(\frac{d^2w}{dr^2}\right)^2 + \left(\frac{1}{r}\frac{dw}{dr}\right)^2 + \frac{2\nu}{r}\frac{dw}{dr}\frac{d^2w}{dr^2}\right\}\frac{h^3}{12} \\ &+ 2(1+\nu)\left\{\int_{-h/2}^{h/2}(\alpha T)^2\,dz + \frac{M_T}{E}\left[\frac{d^2w}{dr^2}+\frac{1}{r}\frac{dw}{dr}\right]\right. \\ &\left.-\frac{N_T}{E}\left[\frac{du}{dr}+\frac{1}{2}\left(\frac{dw}{dr}\right)^2+\frac{u}{r}\right]\right\}\Bigg]dr - 2\pi\int_0^b q\,w\,r\,dr + \pi b\lambda(u_b)^2 \end{aligned} \tag{4}$$

4.3.3 Governing Differential Equations and Boundary Conditions

The equilibrium equations and "natural" boundary conditions are now obtained by making the potential energy stationary with respect to variations of the displacements w and u; i.e. $\delta_w V = \delta_u V = 0$. The first of the variations $(\delta_w V = 0)$ yields the equilibrium equation

$$D\nabla^4 w - \frac{1}{r}\frac{d}{dr}\left(r N_r \frac{dw}{dr}\right) = q - \frac{\nabla^2 M_T}{1-\nu} \tag{1}$$

and the following boundary conditions:

(1) $r = 0$

Assumed regularity of the solution at the center requires that M_r and M_t be finite. This implies that $\frac{dw}{dr} = 0$ and $M_r = M_t$. (2a)

4.3.3 (Cont'd)

(2) $\underline{r = b}$

(i) w prescribed or $-\frac{d}{dr}\left[D\nabla^2 w + \frac{M_T}{1-\nu}\right] + N_r \frac{dw}{dr} = 0$

(2b)

(ii) w' prescribed or $D\left[\frac{d^2 w}{dr^2} + \frac{\nu}{r}\frac{dw}{dr}\right] + \frac{M_T}{1-\nu} = 0$.

The second of the variations ($\delta_u V = 0$) results in

$$N_t - \frac{d}{dr}(r N_r) = 0 \tag{3}$$

with boundary conditions:

(1) $\underline{r = 0}$

N_r and N_t finite. This implies that $u = 0$ (hence $N_r = N_t$) . (4a)

(2) $\underline{r = b}$

$$\left(u + \frac{N_r}{\lambda}\right) = 0 \text{ or } u \text{ prescribed.} \tag{4b}$$

The two equations (1) and (3) contain three unknown functions of r ; i.e., w, N_r and N_t. A third equation is obtained from the necessary condition that these three quantities yield a set of single-valued displacements, u and w. A statement of this requirement is obtained by eliminating u from Equation (4b) of Paragraph 4.3.1, which results in

$$\frac{d\epsilon_t^o}{dr} + \frac{\epsilon_t^o - \epsilon_r^o}{r} = -\frac{1}{2r}\left(\frac{dw}{dr}\right)^2 . \tag{5a}$$

Substituting (4a) of Paragraph 4.3.1 into (5a),

$$\frac{d}{dr}(N_t - \nu N_r + N_T) + \frac{(1+\nu)}{r}(N_t - N_r) + \frac{Eh}{2r}\left(\frac{dw}{dr}\right)^2 = 0 \tag{5b}$$

Equation (3) is automatically satisfied by a stress function ψ defined through the relations

$$\psi = r N_r$$

(6)

$$\frac{d\psi}{dr} = N_t .$$

Substitution of (6) into Eqs. (1) and (5b) results in the following coupled set of non-linear differential equations

$$D\nabla^4 w - \frac{1}{r}\frac{d}{dr}\left(\psi \frac{dw}{dr}\right) = q - \frac{1}{1-\nu}\nabla^2 M_T \tag{7}$$

and

$$\frac{d^2\psi}{dr^2} + \frac{1}{r}\frac{d\psi}{dr} - \frac{\psi}{r^2} + \frac{Eh}{2r}\left(\frac{dw}{dr}\right)^2 = -\frac{d}{dr} N_T \tag{8}$$

where

$$\nabla^2 = \frac{1}{r}\frac{d}{dr} r \frac{d}{dr}$$

$$\nabla^4 = \nabla^2 \nabla^2 .$$

A more convenient form is obtained by introducing the slope $\beta = \frac{dw}{dr}$, which yields

$$D \frac{d}{dr} r \frac{d}{dr} \frac{1}{r} \frac{d}{dr} (r\beta) - \frac{d}{dr}(\psi\beta) = qr - \frac{1}{1-\nu}\frac{d}{dr}\left(r \frac{dM_T}{dr}\right) \tag{9}$$

and

$$\frac{d^2\psi}{dr^2} + \frac{1}{r}\frac{d\psi}{dr} - \frac{\psi}{r^2} + \frac{Eh}{2r}\beta^2 = -\frac{d}{dr} N_T . \tag{10}$$

Equation (9) may now be integrated with respect to r, resulting in

$$D\left(\frac{d^2\beta}{dr^2} + \frac{1}{r}\frac{d\beta}{dr} - \frac{\beta}{r^2}\right) - \frac{\beta\psi}{r} = \frac{1}{r}\int_0^r q(\eta)\cdot\eta\, d\eta - \frac{1}{1-\nu}\frac{d}{dr} M_T . \tag{11}$$

The Eqs. (10) and (11) are to be solved subject to the boundary conditions (obtained from (2) and (4))

(i) $\beta(o) = 0$

(ii) $\beta(b)$ prescribed (known slope)
or
$$D\left[\frac{d\beta}{dr} + \frac{\nu}{r}\beta\right]_{r=b} + \left[\frac{M_T}{1-\nu}\right]_{r=b} = 0 \quad \text{(no radial bending moment)} \tag{12}$$

(iii) $\psi(o) = 0$ (since N_r is finite at $r = 0$)

$$\text{(iv)} \quad \left[\frac{d\psi}{dr} + \left(\frac{Eh}{b^2\lambda} - \frac{\nu}{b}\right)\psi + N_T\right]_{r=b} = 0 \quad \text{(elastic radial restraint "}\lambda\text{" at } r=b\text{)}$$

or

$$\left[\frac{d\psi}{dr} - \frac{\nu}{r}\psi + N_T\right]_{r=b} \text{ prescribed (known radial displacement at } r=b\text{)}$$

The above differential equations and boundary conditions can be expressed in non-dimensional form as

$$\ddot{\theta} + \frac{\dot{\theta}}{\bar{r}} - \frac{\theta}{\bar{r}^2} - \frac{\theta\phi}{\bar{r}} = \bar{r}\,Q(\bar{r}) - \dot{\bar{M}}_T$$

$$\ddot{\phi} + \frac{\dot{\phi}}{\bar{r}} - \frac{\phi}{\bar{r}^2} + \frac{\theta^2}{\bar{r}} = -\dot{\bar{N}}_T \tag{13}$$

where:

$$\bar{r} = \frac{r}{b}, \quad 0 < \bar{r} < 1$$

$$\left(\cdot = \frac{d}{d\bar{r}}\right)$$

$$\phi = \frac{\psi b}{D}$$

$$\theta = \frac{b}{h}\sqrt{6(1-\nu^2)}\;\beta$$

$$Q(\bar{r}) = \frac{2b^4}{Eh^4}\left[6(1-\nu^2)\right]^{3/2}\frac{1}{\bar{r}^2}\int_0^{\bar{r}} q(\xi)\,\xi\,d\xi \tag{14}$$

$$\bar{M}_T = \frac{M_T b^2}{Dh}\sqrt{\frac{6(1+\nu)}{1-\nu}}$$

$$\bar{N}_T = \frac{N_T b^2}{D} .$$

4.3.3 (Cont'd)

The boundary conditions become:

(1) $\theta(0) = 0$

(2) $\phi(0) = 0$

(3) $\theta(1)$ prescribed

or

$$\dot{\theta}(1) + \upsilon\,\theta(1) + \overline{M}_T(1) = 0 \tag{14a}$$

(4) $\dot{\phi}(1) + \left(\frac{Eh}{b\lambda} - \upsilon\right)\phi(1) + \overline{N}_T(1) = 0$

or

$\dot{\phi}(1) - \upsilon\,\phi(1) + \overline{N}_T(1)$ prescribed

The set of nonlinear differential Equations (13) and accompanying boundary conditions (14a) are not amenable to analytic solution. Numerical procedures must be used to obtain solutions for specified values of the parameters. A finite-difference approach is presented below together with numerical results.

4.4 NUMERICAL INVESTIGATION

4.4.1 Finite Difference Procedure

The procedure developed in Reference 4-4 is employed here for the combined thermo-mechanical problem. In particular, we consider the case of radially immovable edges ($\lambda \to \infty$ in (14a) of Paragraph 4.3.3) with simple supports for bending where q, M_T, and N_T are constant (uniform pressure and temperature which varies only through the thickness). For this problem, (13) and (14a) of Paragraph 4.3.3 reduce to

$$
\begin{aligned}
L\theta &= \theta\phi + Q\bar{r}^2 \\
L\phi &= -\theta^2
\end{aligned}
\tag{1}
$$

and

$$
\begin{aligned}
&\theta(0) = 0 \\
&\phi(0) = 0 \\
&\dot{\theta}(1) + \nu\theta(1) + \bar{M}_T = 0 \\
&\dot{\phi}(1) - \nu\phi(1) + \bar{N}_T = 0
\end{aligned}
\tag{2}
$$

where

$$
L = \bar{r}\,\frac{d}{d\bar{r}}\,\frac{1}{\bar{r}}\,\frac{d}{d\bar{r}}\,\bar{r}
$$

$$
Q = \frac{q}{E}\left(\frac{b}{h}\right)^4 \left[6(1-\nu^2)\right]^{3/2}
$$

and the other nondimensional quantities are as defined previously.

A central difference representation of the differential equations (1) yields the following for the interior points:

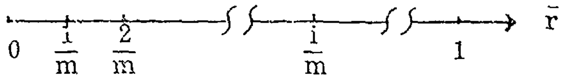
$$
\begin{aligned}
\bar{L}\theta_i &= \theta_i\phi_i + Q\left(\frac{i}{m}\right)^2 \\
\bar{L}\phi_i &= -\theta_i^2
\end{aligned}
\qquad (i = 1, 2, \ldots, m-1,)
\tag{3}
$$

where for an arbitrary function ζ,

$$\bar{L}(\zeta_i) = \frac{im}{i+.5}\left[(i+1)\,\zeta_{i+1} - i\,\zeta_i\right] - \frac{im}{i-.5}\left[i\,\zeta_i - (i-1)\,\zeta_{i-1}\right] \qquad (3a)$$

m = number of subdivisions

$\bar{r}_i = \frac{i}{m}$



The finite difference form for the representation of the boundary conditions may be written as

$$\theta_o = 0$$

$$\phi_o = 0$$

$$\theta_m = \left[\frac{m\theta_{m-1} - \frac{M_T b^2}{Dh}\sqrt{\frac{6(1+\nu)}{1-\nu}}}{(m+\nu)}\right] \qquad (4)$$

$$\phi_m = \left[\frac{m\phi_{m-1} - \frac{N_T b^2}{D}}{m-\nu}\right]$$

where backward differences are used for the end point $\bar{r} = 1$.

Equations (3) and (4) constitute a set of $2(m+1)$ equations in the $2(m+1)$ unknowns θ_i, ϕ_i ($i = 0, 1, 2, \ldots m$). However, these algebraic equations are both coupled and nonlinear, and cannot be solved in closed form. A "relaxed iteration" technique is employed, in which the iterative forms of equations (3) are written as

$$\left[\bar{L}\phi_i\right]_{n+1} = -\left[\theta_i^2\right]_n \qquad (5a)$$

$$\left[\bar{L}\theta_i^*\right]_{n+1} = \left[\theta_i\right]_n\left[\phi_i\right]_{n+1} + Q\left(\frac{i}{m}\right)^2 \qquad (5b)$$

$$\left[\theta_i\right]_{n+1} = K\left[\theta_i^*\right]_{n+1} + \left[1-K\right]\left[\theta_i\right]_n \qquad (5c)$$

$$(i = 1, 2, 3 \ldots m-1)$$

where K is a "relaxation" parameter.

A typical iteration, starting with the n'th set of iterates $\left[\theta_i\right]_n$ is as follows:

(1) Substitution of $\left[\theta_i\right]_n$ into (5a) and making use of the second and fourth of Eq. (4) yields a set of $(m-1)$ tri-diagonal, linear algebraic equations from which the quantities $\left[\phi_i\right]_{n+1}$ are determined.

4.4.1 (Cont'd)

(2) Substituting $\left[\theta_i\right]_n$, $\left[\phi_i\right]_{n+1}$ into (5b) again yields a set of linear equations from which the provisional values $\left[\theta_i^*\right]_{n+1}$ for the next set of iterates are determined.

(3) The actual value of the next set of iterates $\left[\theta_i\right]_{n+1}$ is obtained from Eq. (5c) where a suitable value of "relaxation" parameter is employed.

(4) Iterations to convergence are performed.

4.4.2 Numerical Results

Based on the procedure indicated, results are presented in both tabular and graphical form (Table 4.4.2-1 and Figures 4.4.2-1 through 4.4.2-6) for the simply supported solid plate with radially immovable edges.

The nondimensional deflections ($\bar{w}$), membrane forces ($\bar{N}_r$ and $\bar{N}_t$), and bending moments ($\bar{M}_r$ and $\bar{M}_t$), presented in the graphs and tables are defined as follows:

$$\begin{aligned} \bar{w} &= \frac{w}{h} \\ \bar{N}_r &= \frac{N_r b^2}{D} \\ \bar{N}_t &= \frac{N_t b^2}{D} \\ \bar{M}_r &= -\frac{M_r b^2}{Dh}\sqrt{6(1-\upsilon^2)} \\ \bar{M}_t &= -\frac{M_t b^2}{Dh}\sqrt{6(1-\upsilon^2)} \; ; \end{aligned} \tag{1}$$

and as defined previously,

$$\bar{r} = \frac{r}{b}$$

$$\bar{M}_T = \frac{Eb^2}{Dh}\sqrt{\frac{6(1+\upsilon)}{1-\upsilon}}\int_{-h/2}^{h/2}\alpha Tz\,dz$$

$$\bar{N}_T = \frac{Eb^2}{D}\int_{-h/2}^{h/2}\alpha T\,dz$$

4.4.2 (Cont'd)

Stresses (in nondimensional form) may be obtained from these formulas (Reference 4-7):

$$\frac{b^2 h \sigma_r}{D} = \frac{12z}{h}\left[\frac{\bar{M}_T - \bar{M}_r}{\sqrt{6(1-\nu^2)}}\right] + \frac{\bar{N}_T}{1-\nu} - 12(1+\nu)\frac{b^2}{h^2}\alpha T + \bar{N}_r$$

$$\frac{b^2 h \sigma_t}{D} = \frac{12z}{h}\left[\frac{\bar{M}_T - \bar{M}_t}{\sqrt{6(1-\nu^2)}}\right] + \frac{\bar{N}_T}{1-\nu} - 12(1+\nu)\frac{b^2}{h^2}\alpha T + \bar{N}_t \qquad (2)$$

A discussion of the numerical results follows.

(1) Thermal Buckling

The thermal buckling problem of a circular plate due to an average elevated temperature through the thickness (proportional to $\bar{N}_T$), where $\bar{M}_T = Q = 0$ and radial edge displacement is prevented, is equivalent to the mechanical buckling problem of a plate having an edge thrust corresponding to a prescribed edge displacement. It is shown in Reference 4-2 that buckling can occur only when the edge thrust exceeds the lowest eigenvalue of the linearized buckling problem. The critical thrust corresponding to this eigenvalue is given by (Reference 4-5):

$$-\left[\sigma_r\right]_{cr} = \frac{(2.05)^2 D}{b^2 h} \qquad (3)$$

Since, for the thermal problem, the thrust (up to buckling) is given by

$$\sigma_r = -\frac{N_T}{h(1-\nu)}, \qquad (4)$$

then from (3), (4), and the definition of $\bar{N}_T$, we find that

$$\left[\bar{N}_T\right]_{cr} = 2.94$$

The postbuckling behavior of the plate is given by the nonlinear analysis; the numerical results are presented in Figure 4.4.2-1 and the first five sub-tables of Table 4.4.2-1. The table employs a floating decimal number system which is to be interpreted as shown by the following examples:

0.5159E 00 $(0.5159) \times (10^0) = 0.5159$

0.5159E 02 $(0.5159) \times (10^2) = 51.59$

0.5159E-01 $(0.5159) \times (10^{-1}) = 0.05159$

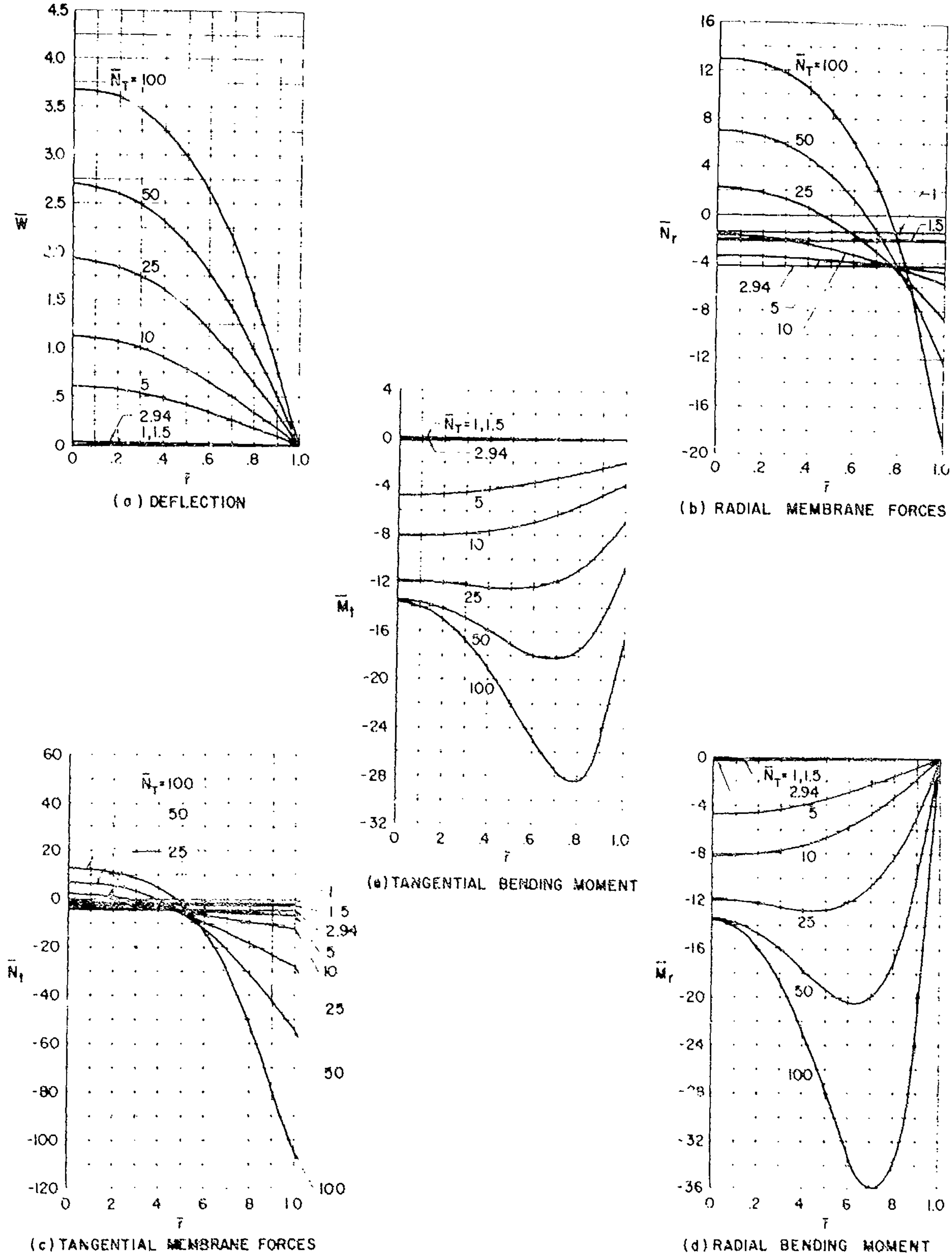


FIGURE 4.4.2-1 NONDIMENSIONAL THERMAL BUCKLING AND POST BUCKLING BEHAVIOR ($\bar{M}_T$ = Q = 0).

4.4.2 (Cont'd)

Figure 4.4.2-1 shows the variation of the nondimensional deflection, membrane stress resultants and bending moments with the nondimensional radial coordinate $\bar{r}$, as $\bar{N}_T$ varies from 0 to 100. It is noted that for $0 < \bar{N}_T < 2.94$ the plate is undeflected, and the two-dimensional linear elastic solution holds, yielding stresses which are constant over the planform and zero bending moments. For higher values of $\bar{N}_T$, Figure 4.4.2-1a shows nonzero deflections that increase monotonically with increasing $\bar{N}_T$. For low values of $\bar{N}_T$, the quantities $\bar{N}_r$ and $\bar{N}_t$ are compressive (Figures 4.4.2-1b and c) throughout the plate. With higher values of $\bar{N}_T$ (25, 50, and 100, for example) deflections in the central region appear to be restrained by tensile membrane stresses, while in the vicinity of the plate edge the membrane stresses become compressive. Figures 4.4.2-1d and e indicate that for small N_T (but above that causing initial buckling), the maximum moments in the radial and tangential directions occur at the center of the plate. With larger $\bar{N}_T$, maximum moments are away from the center and approach the outer edge as $\bar{N}_T$ increases. The radial moment, in particular, exhibits a strong "boundary layer" effect (sharp gradients near the edge) in meeting the condition $\left[\bar{M}_r\right]_{\bar{r}=1} = 0$.

(2) Bending Due To Combined Thermal And Mechanical Effects

Starting with the sixth sub-table of Table 4.4.2-1, nondimensional numerical results are listed for the thermal bending problem (Q = 0), corresponding to the following combinations of thermal parameters:

$\bar{M}_T$ = 50, 100, 1000, 2000

$\bar{N}_T$ = 0, 2.94, 5, 10, 25, 100

For a qualitative discussion of the results, we refer to the graphs of Figures 4.4.2-2 through 4.4.2-6 in which mechanical loads ($Q \neq 0$) as well as temperature are considered.

(a) <u>Deflections (Figure 4.4.2-2)</u>

For low pressures (quantities proportional to Q) the deflection in the plate interior becomes constant for large temperature differences (quantities proportional to $\bar{M}_T$). This flat deflected shape is maintained almost to the plate edges where the boundary requirement of zero deflection causes a boundary layer effect in which the deflections drop precipitously. This effect becomes less pronounced as the pressure loading increases. However, it is interesting to note that even for high pressure loading (Figure 4.4.2-2d), the plate still tends to flatten out in the central region as the temperature difference increases and, contrary to what would be expected, the deflection at the center does <u>not</u> in all cases increase monotonically with the temperature difference.

(b) <u>Membrane Stresses (Figures 4.4.2-3 and 4.4.2-4)</u>

With increasing temperature difference between the plate faces, the radial and tangential stresses tend to become constant and equal to each other in the plate interior,

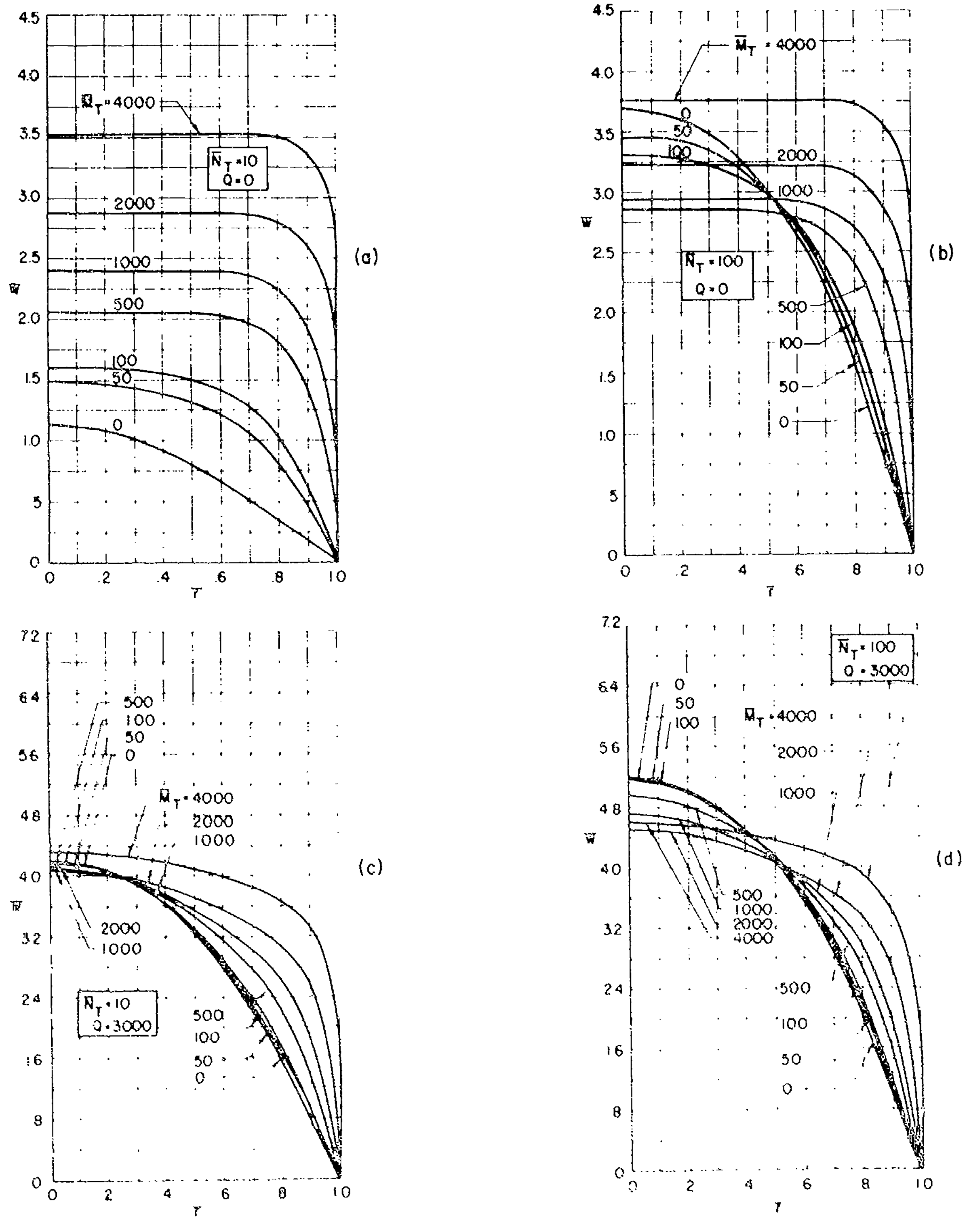


FIGURE 4.4.2-2 NONDIMENSIONAL DEFLECTIONS DUE TO TEMPERATURE WITH AND WITHOUT PRESSURE LOADING

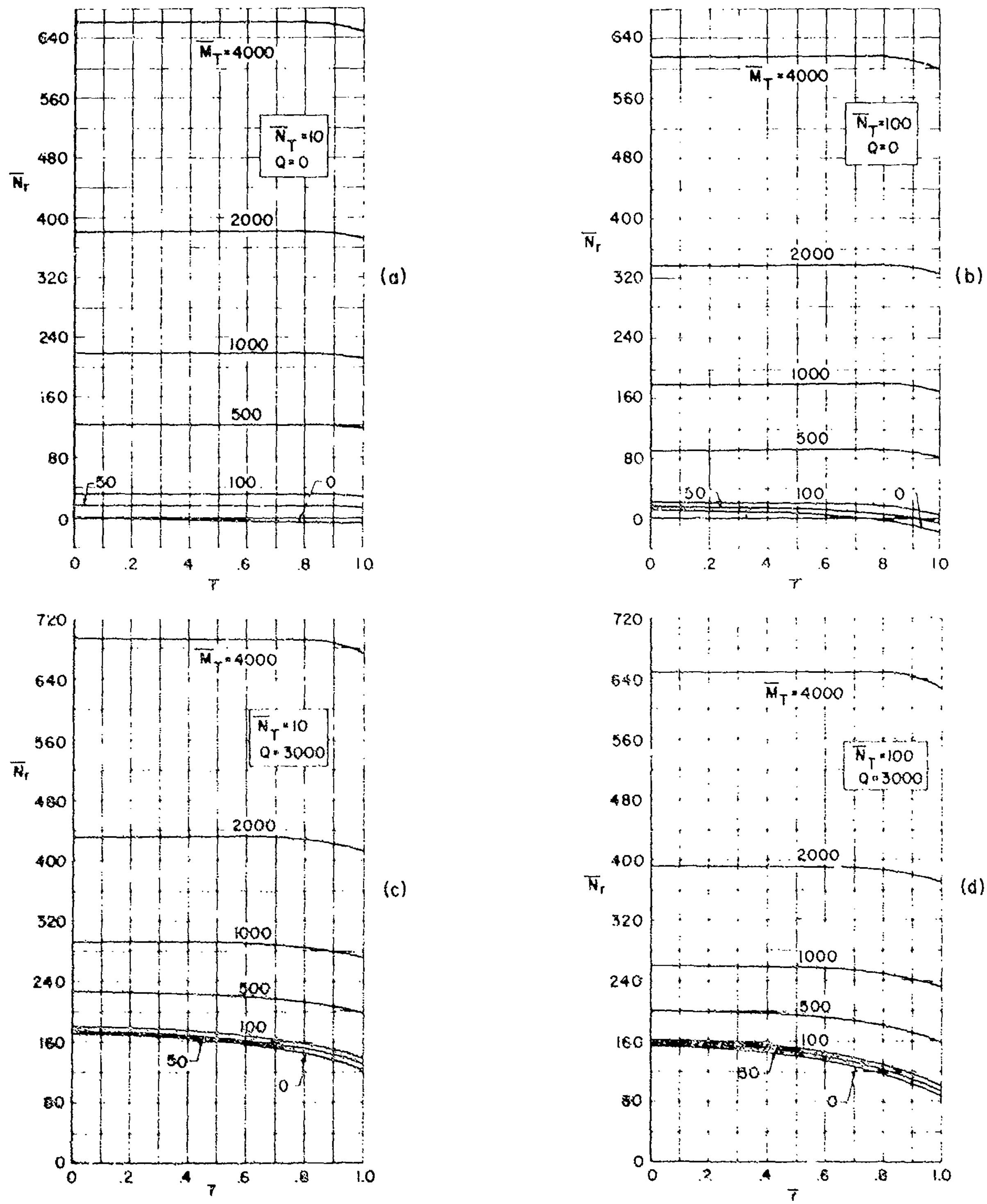


FIGURE 4.4.2-3 NONDIMENSIONAL RADIAL MEMBRANE FORCES DUE TO TEMPERATURE WITH AND WITHOUT PRESSURE LOADING

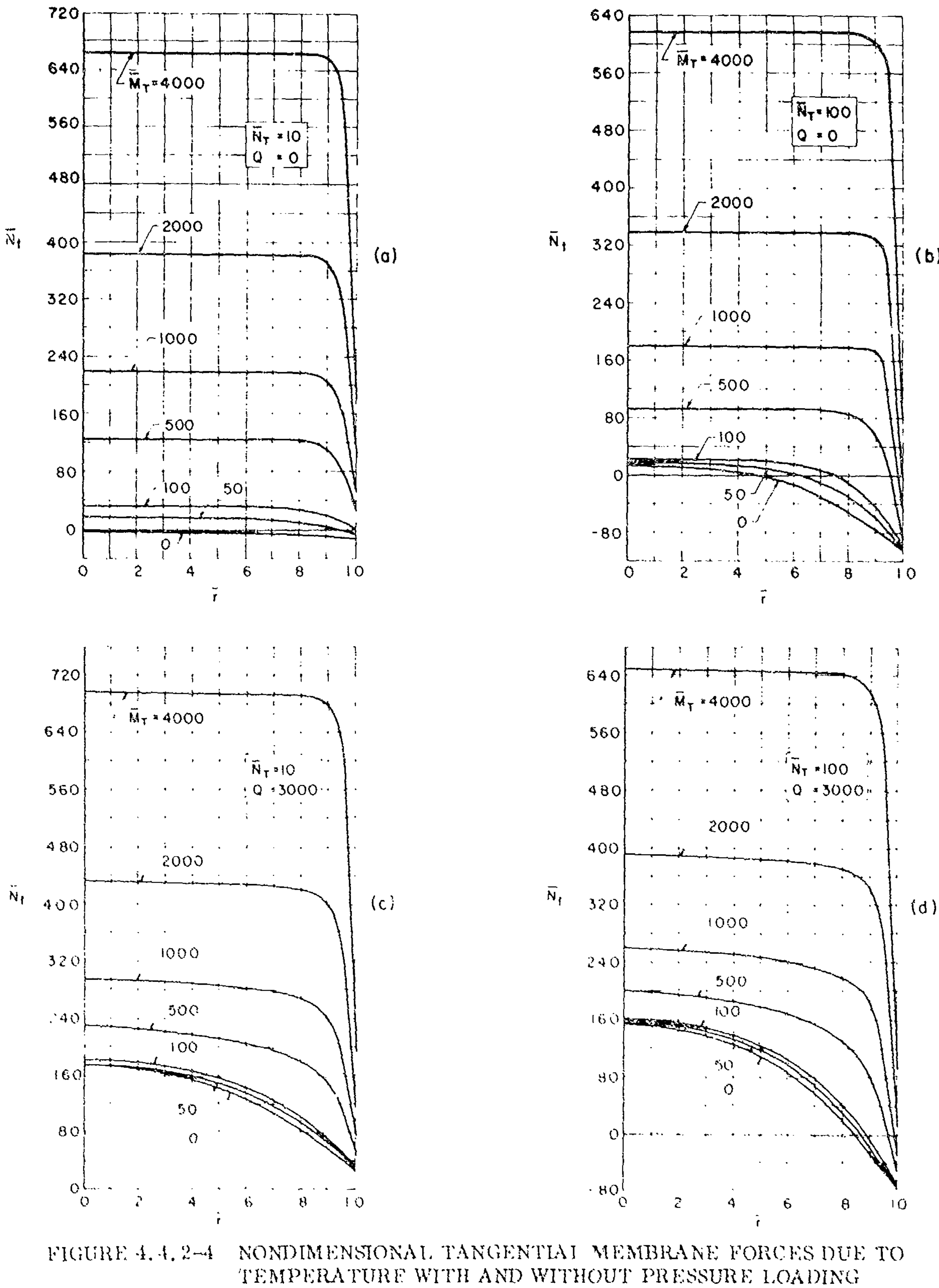


FIGURE 4.4.2-4 NONDIMENSIONAL TANGENTIAL MEMBRANE FORCES DUE TO TEMPERATURE WITH AND WITHOUT PRESSURE LOADING

as in a pure membrane. This effect is evident even for high pressure loading, (Figures 4.4.2-3d and 4d). In addition, the magnitudes of these tensile membrane stress resultants increase with increasing temperature difference and normal pressure while they decrease with increasing average temperature (quantities proportional to $\bar{N}_T$). This is to be expected, since increasing the pressure and temperature difference each cause additional middle plane stretching while $\bar{N}_T$ tends to neutralize this effect. The membrane tension $\bar{N}_r$, decreases locally as the outer boundary is approached, where the gradients are most pronounced. This negative increment $\Delta\bar{N}_r$, may be responsible for the abrupt reduction in tensile hoop stresses ($\bar{N}_t$) in the vicinity of the edge (Figure 4.4.2-4). For the larger values of average temperature, the high tensile stress resultants $\bar{N}_t$, in the plate interior reduce sharply in a boundary layer. Low temperature differences permit transition to compression near the boundary (Figures 4.4.2-4b and d).

(c) Bending Moments (Figures 4.4.2-5 and -6)

The bending moments in the radial and tangential directions are constant and essentially equal over the major central area of the plate. However, radial moments decrease radically near the boundary, satisfying the zero moment boundary condition. Due to the predominantly flat profile of the deflected plate in the interior for large temperature differences (Figures 4.4.2-2a and b), it may be conjectured that the constant and equal interior moments are the same as would occur in a clamped plate subjected to the same temperature gradient (since such a plate will remain flat). To show that this is the case, we proceed as follows:

The bending moments in a fully clamped plate subjected to a thermal gradient through the thickness are given by (Reference 4-8)

$$M_r = M_t = -\frac{M_T}{1-\nu}$$

while

$$w \equiv 0$$

or, in nondimensional form, using the notation of (14) of Paragraph 4.3.3 and (1)

$$\bar{M}_r = \bar{M}_t = \bar{M}_T$$

This result is readily verified by Figures 4.4.2-5 and -6.

ACKNOWLEDGEMENT

The numerical calculations appearing in this section were performed on the Republic Aviation Corporation IBM 7090 digital computer. The authors wish to express their thanks to M. Gershinsky and B. Sackaroff of the Applied Math. Section, Digital Computing Division for their excellent work in coding and supervising the numerical program.

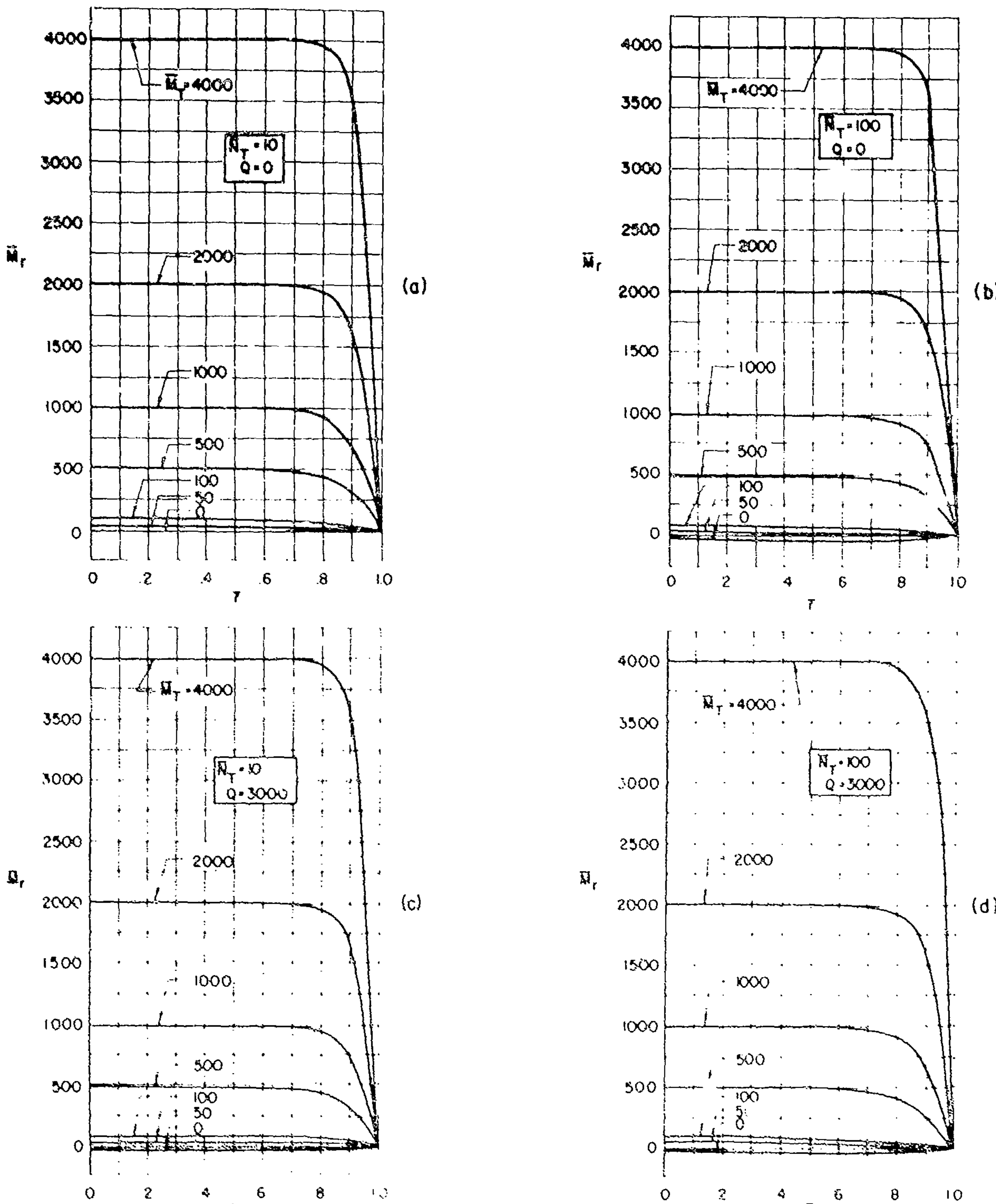


FIGURE 4.4.2-5 NONDIMENSIONAL RADIAL BENDING MOMENTS DUE TO TEMPERATURE WITH AND WITHOUT PRESSURE LOADING

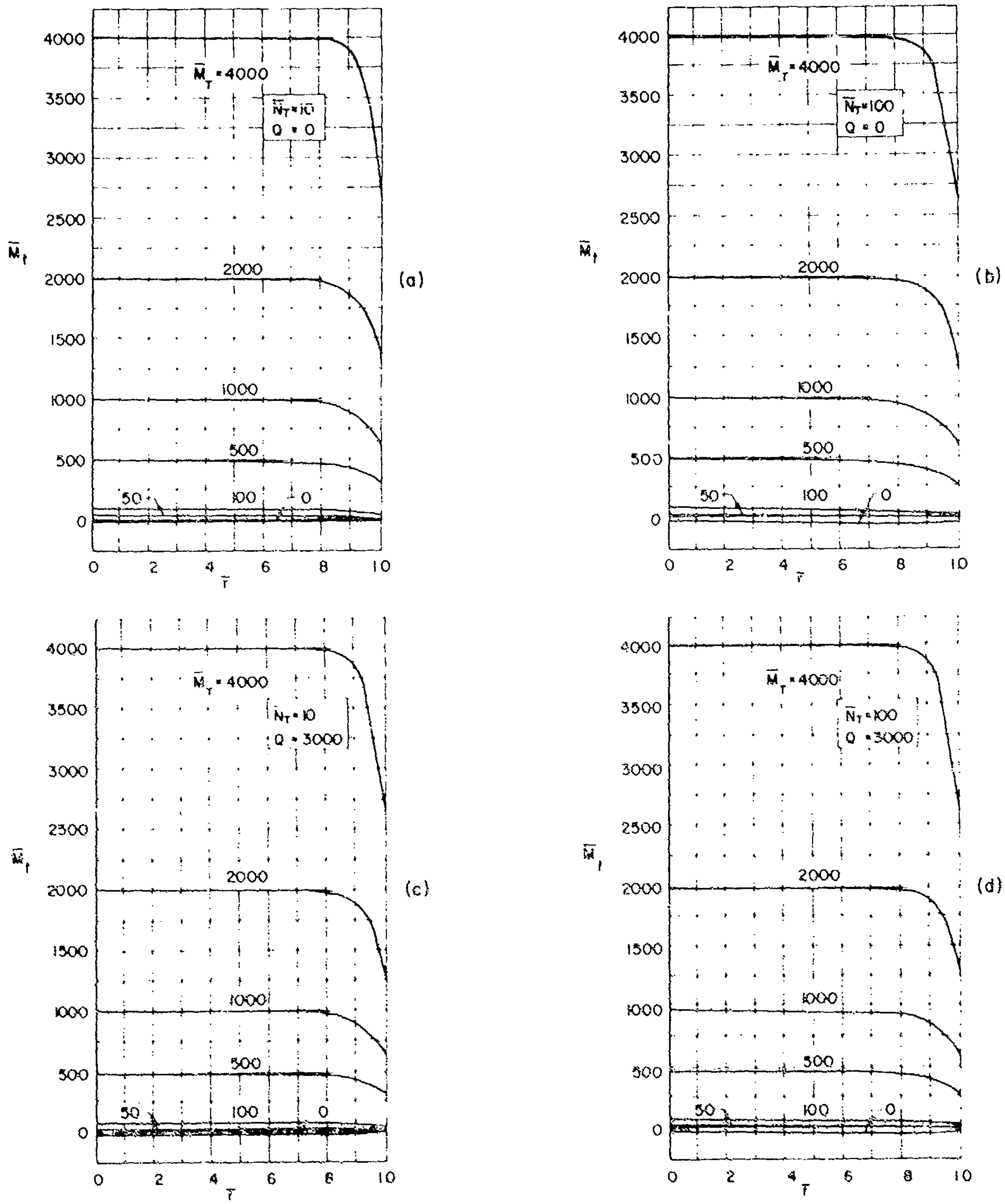


FIGURE 4.4.2-6 NONDIMENSIONAL TANGENTIAL BENDING MOMENTS DUE TO TEMPERATURE WITH AND WITHOUT PRESSURE LOADING

4.4.2 (Cont'd)

TABLE 4.4.2-1

NONDIMENSIONAL DEFLECTIONS, MEMBRANE FORCES, AND BENDING MOMENTS FOR A SIMPLY SUPPORTED CIRCULAR PLATE WITH RADIALLY IMMOVABLE EDGE

(Pages 4.25 through 4.35)

4.4.2 (Cont'd)

TABLE 4.4.2-1 (Cont'd)

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
	$\bar{M}_T = 0.$			$\bar{N}_T = 0.2940E\ 01$	
0.	0.2600E-01	-0.4193E 01	-0.4193E 01	-0.2072E-00	-0.2072E-00
0.1000E-00	0.2566E-01	-0.4193E 01	-0.4193E 01	-0.2043E-00	-0.2055E-00
0.2000E-00	0.2465E-01	-0.4193E 01	-0.4193E 01	-0.1960E-00	[illegible]
0.3000E-00	0.2300E-01	-0.4193E 01	-0.4194E 01	-0.1824E-00	[illegible]
0.4000E-00	0.2077E-01	-0.4193E 01	-0.4194E 01	-0.1642E-00	[illegible]
[illegible]	[illegible]	-0.4194E 01	[illegible]	-0.1417E-00	-0.1620E-00
0.6000E-00	[illegible]	-0.4194E 01	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	-0.4194E 01	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	-0.4197E 01	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.	[illegible]	[illegible]	[illegible]	[illegible]
	$\bar{M}_T = 0.$			$\bar{N}_T$ = [illegible]	
0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	$\bar{M}_T = 0.$			$\bar{N}_T$ = [illegible] E 02	
0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	-0.7282E 01	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.	[illegible]	[illegible]	[illegible]	[illegible]

4.4.2 (Cont'd)

TABLE 4.4.2-1 (Cont'd)

$\bar{M}_T = 0.$ $\bar{N}_T = 0.2500E\ 02$

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.1936E 01	0.2361E 01	0.2361E 01	0.1179E 02	-0.1179E 02
0.1000E-00	0.1916E 01	0.2250E 01	0.2039E 01	-0.1188E 02	-0.1164E 02
0.2000E-00	0.1857E 01	0.1938E 01	0.1098E 01	-0.1211E 02	-0.1198E 02
0.3000E-00	0.1759E 01	0.1411E 01	-0.5052E 00	-0.1242E 02	-0.1217E 02
0.4000E-00	0.1619E 01	0.6603E 00	-0.2812E 01	-0.1268E 02	-0.1236E 02
0.5000E-00	0.1437E 01	-0.32[illegible]	-0.5852E 01	-0.1269E 02	-0.1245E 02
0.6000E-00	0.1212E 01	-0.15[illegible] 01	-0.9613E 01	-0.1218E 02	-0.1232E 02
0.7000E-00	0.9491E 00	-0.3007E 01	-0.1399E 02	-0.1085E 02	-0.1182E 02
0.8000E-00	0.6514E 00	-0.4677E 01	-0.1878E 02	-0.8402E 01	-0.10[illegible] 02
0.9000E-00	0.3298E-00	-0.6514E 01	-0.2359E 02	-0.4600E 01	-0.9149E 01
1.0000E-00	0.	-0.8445E 01	-0.2753E 02	-0.5334E-05	-0.[illegible]65E 01

$\bar{M}_T = 0.$ $\bar{N}_T = 0.1000E\ 03$

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.3684E 01	0.1306E 02	0.1306E 02	-0.1357E 02	-0.13[illegible] 02
0.1000E-00	0.3662E 01	0.1292E 02	0.1263E 02	-0.1416E 02	-0.1392E 02
0.2000E-00	0.3592E 01	0.1248E 02	0.1128E 02	-0.1587E 02	-0.1490E 02
0.3000E-00	0.3468E 01	0.1170E 02	0.8718E 01	-0.1877E 02	-0.1656E 02
0.4000E-00	0.3272E 01	0.1046E 02	0.4373E 01	-0.2281E 02	-0.1889E 02
0.5000E-00	0.[illegible]08E 01	0.8602E 01	-0.2625E 01	-0.2773E 02	-0.2178E 02
0.6000E-00	0.2639E 01	0.5893E 01	-0.1350E 02	-0.3274E 02	-0.2492E 02
0.7000E-00	0.2151E 01	0.2042E 01	-0.2968E 02	-0.3601E 02	-0.2757E 02
0.8000E-00	0.1534E 01	-0.3253E 01	-0.5210E 02	-0.3417E 02	-0.2833E 02
0.9000E-00	0.7997E 00	-0.1018E 02	-0.7981E 02	-0.2240E 02	-0.2517E 02
1.0000E-00	0.	-0.1859E 02	-0.1055E 03	0.2771E-04	-0.1[illegible] 02

$\bar{M}_T = 0.5000E\ 02$ $\bar{N}_T = 0.$

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.1180E 01	0.2166E 02	0.2166E 02	0.4794E 02	0.47[illegible]
0.1000E-00	0.1177E 01	0.2165E 02	0.2165E 02	0.477[illegible] 02	0.47[illegible]
0.2000E-00	0.1166E 01	0.2164E 02	0.2161E 02	0.4733E 02	0.47[illegible]
0.3000E-00	0.1145E 01	0.2162E 02	0.2154E 02	[illegible]	0.471[illegible]
0.4000E-00	0.1113E 01	0.2159E 02	0.2141E 02	[illegible]	0.46[illegible]
0.5000E-00	0.10[illegible] 01	0.2153E 02	0.2115E 02	0.4[illegible]	0.45[illegible]
0.6000E-00	0.9841E 00	0.2143E 02	0.2064E 02	0.3[illegible]	0.43[illegible]
0.7000E-00	[illegible]	0.2125E 02	0.1963E 02	0.3[illegible]	0.4092E 02
0.8000E-00	0.[illegible] 00	0.2094E 02	0.1757E 02	[illegible]	0.37[illegible]
0.9000E-00	0.4129E 00	0.2036E 02	0.1333E 02	0.1[illegible] 02	0.3164E 02
1.0000E-00	0.	0.1977E 02	0.5783E 01	0.21[illegible]E-01	0.2499E 02

TABLE 4.4.2-1 (Cont'd)

$\bar{M}_T = 0.5000E\ 02$ $\bar{N}_T = 0.2940E\ 01$

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.1270E 01	0.2027E 02	0.2027E 02	0.4760E 02	0.4760E 02
0.1000E-00	0.1266E 01	0.2027E 02	0.2026E 02	0.4744E 02	0.4751E 02
0.2000E-00	0.1254E 01	0.2025E 02	0.2021E 02	0.4694E 02	0.4722E 02
0.3000E-00	0.1230E 01	0.2022E 02	0.2012E 02	0.4603E 02	0.4671E 02
0.4000E-00	0.1193E 01	0.2018E 02	0.1995E 02	0.4454E 02	0.4590E 02
0.5000E-00	0.1136E 01	0.2010E 02	0.1962E 02	0.4224E 02	0.4468E 02
0.6000E-00	0.1049E 01	0.1998E 02	0.1899E 02	0.3875E 02	0.4288E 02
0.7000E-00	0.9187E 00	0.1976E 02	0.1778E 02	0.3352E 02	0.4025E 02
0.8000E-00	0.7239E 00	0.1938E 02	0.1532E 02	0.2575E 02	0.3644E 02
0.9000E-00	0.4330E-00	0.1871E 02	0.1060E 02	0.1438E 02	0.3098E 02
1.0000E-00	0.	0.1747E 02	0.2329E 01	-0.7152E-05	0.2385E 02

$\bar{M}_T = 0.5000E\ 02$ $\bar{N}_T = 0.5000E\ 01$

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.1334E 01	0.1943E 02	0.1943E 02	0.4736E 02	0.4736E 02
0.1000E-00	0.1330E 01	0.1942E 02	0.1941E 02	0.4718E 02	0.4726E 02
0.2000E-00	0.1316E 01	0.1940E 02	0.1936E 02	0.4666E 02	0.4696E 02
0.3000E-00	0.1291E 01	[illegible]	0.1925E 02	0.4570E 02	[illegible]
0.4000E-00	0.1250E 01	[illegible]	0.1904E 02	0.4415E 02	0.4557E 02
0.5000E-00	0.1188E 01	[illegible]	0.1866E 02	0.4178E 02	0.4431E 02
0.6000E-00	0.1094E 01	0.1908E 02	0.1794E 02	[illegible]	[illegible]
0.7000E-00	0.9561E 00	[illegible]	0.1657E 02	[illegible]	0.3978E 02
0.8000E-00	0.7507E 00	0.1840E 02	0.1392E 02	0.2513E 02	0.3594E 02
0.9000E-00	0.4472E-00	0.1766E 02	0.8734E 01	0.1392E 02	0.3052E 02
1.0000E-00	0.	0.1631E 02	-0.6811E-01	[illegible]	0.2355E 02

$\bar{M}_T = 0.5000E\ 02$ $\bar{N}_T = 0.1000E\ 02$

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	[illegible]	[illegible]	0.1776E 02	0.4675E 02	0.4675E 02
0.1000E-00	0.1484E 01	0.1775E 02	0.1774E 02	[illegible]	0.4663E 02
0.2000E-00	0.1467E 01	0.1773E 02	0.1766E 02	[illegible]	0.4630E 02
0.3000E-00	0.1436E 01	0.1768E 02	0.1749E 02	0.4490E 02	0.4570E 02
0.4000E-00	0.1388E 01	0.1760E 02	0.1720E 02	0.4321E 02	0.4477E 02
0.5000E-00	0.1314E 01	0.1747E 02	0.1667E 02	0.4066E 02	0.4340E 02
0.6000E-00	0.1206E 01	0.1727E 02	0.1569E 02	[illegible]	0.4143E 02
0.7000E-00	0.1046E 01	0.1693E 02	0.1390E 02	[illegible]	0.3864E 02
0.8000E-00	0.8155E 00	0.1636E 02	0.1057E 02	[illegible]	0.3474E 02
0.9000E-00	[illegible]	0.1541E 02	0.4325E 01	0.1283E 02	0.2941E 02
1.0000E-00	0.	0.1378E 02	[illegible]	-0.8106E-05	[illegible]

4.4.2 (Cont'd)

TABLE 4.4.2-1 (Cont'd)

$\bar{M}_T$ = 0.5000E 02 $\bar{N}_T$ = 0.2500E 02

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.1936E 01	0.1510E 02	0.1510E 02	0.4498E 02	0.4498E 02
0.1000E-00	0.1928E 01	0.1508E 02	0.1504E 02	0.4473E 02	0.4483E 02
0.2000E-00	0.1902E 01	0.1502E 02	0.1486E 02	0.4397E 02	0.4440E 02
0.3000E-00	0.1855E 01	0.1491E 02	0.1449E 02	0.4261E 02	0.4363E 02
0.4000E-00	0.1783E 01	0.1474E 02	0.1384E 02	0.4051E 02	0.4247E
0.5000E-00	0.1676E 01	0.1446E 02	0.1273E 02	0.3743E 02	0.4080E 02
0.6000E-00	0.1522E 01	0.1402E 02	0.1082E 02	0.3311E 02	0.3848E 02
0.7000E-00	0.1305E 01	0.1335E 02	0.7521E 01	0.2719E 02	0.3537E 02
0.8000E-00	0.1001E 01	0.1230E 02	0.1813E 01	0.1939E 02	0.3131E 02
0.9000E-00	0.[illegible]E 00	0.1064E 02	-0.8014E 01	0.9722E 01	0.2625E 02
1.0000E-00	0.	0.8025E 01	-0.2254E 02	-0.1232E-04	0.2074E 02

$\bar{M}_T$ = 0.5000E 02 $\bar{N}_T$ = 0.1000E 03

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.3[illegible]E 01	0.1[illegible]E 02	0.1[illegible]E 02	[illegible]	0.4085E 02
0.1000E-00	0.3471E 01	0.1679E 02	0.1[illegible]E 02	[illegible]	0.4[illegible]E 02
0.2000E-00	0.3470E 01	0.16[illegible]E 02	0.1504E 02	[illegible] 02	0.3[illegible]E 02
0.3000E-00	0.3340E 01	0.16[illegible]E 02	0.1476E 02	0.3[illegible]E 02	0.3812E 02
0.4000E-00	0.3205E 01	0.1[illegible]E 02	0.1[illegible]E 02	0.21[illegible]E 02	0.3577E 02
0.5000E-00	0.3073E 01	0.14[illegible]E 02	0.8565E 01	[illegible] 02	0.3248E 02
0.6000E-00	0.27[illegible]E 01	0.1[illegible]E 02	0.1[illegible]E 01	0.17[illegible]E 02	0.2813E 02
0.7000E-00	0.2301E 01	0.1[illegible]E 02	-0.1[illegible]	0.8330E 01	0.2280E 02
0.8000E-00	0.1732E 01	0.[illegible]256E 01	-0.3012E 02	-0.1230E 01	0.1707E 02
0.9000E-00	0.9598E 00	0.1[illegible]E 01	-0.[illegible]E 02	-0.6317E 01	0.1[illegible]E 02
1.0000E-00	0.	-0.7233E 01	-0.1020E 03	-0.2[illegible]E-05	0.1231E 02

$\bar{M}_T$ = 0.1000E 03 $\bar{N}_T$ = 0.

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.1386E 01	0.371[illegible]E 02	0.37[illegible]E 02	0.[illegible]E 02	0.[illegible]E 02
0.1000E-00	0.13[illegible]E 01	0.371[illegible]E 02	0.371[illegible]E 02	0.[illegible]77E 02	0.[illegible]E 02
0.2000E-00	0.1378E 01	0.371[illegible]E 02	0.3[illegible]E 02	0.[illegible]E 02	0.[illegible]E 02
0.3000E-00	0.136[illegible]E 01	0.37[illegible]E 02	0.[illegible]11E 02	0.[illegible]E 02	0.[illegible]11E 02
0.4000E-00	0.1344E 01	0.3714E 02	0.3703E 02	0.[illegible]E 02	0.[illegible]E 02
0.5000E-00	0.1307E 01	0.371[illegible]E 02	0.36[illegible]E 02	0.930[illegible]E 02	0.958[illegible]E 02
0.6000E-00	0.12[illegible]E 01	0.3703E 02	0.3643E 02	0.8[illegible]E 02	0.93[illegible]E 02
0.7000E-00	0.1130E 01	0.36[illegible]E 02	0.3543E 02	0.7[illegible]E 02	0.[illegible]E 02
0.8000E-00	0.[illegible]E 00	0.3[illegible]E 02	0.32[illegible]E 02	0.[illegible]E 02	0.82[illegible]E 02
0.9000E-00	0.[illegible]E 00	0.35[illegible]E 02	0.[illegible]E [illegible]	0.3[illegible]E 02	0.7111E 02
1.0000E-00	0.	0.3408E 02	0.1015E 02	0.[illegible]E-01	0.53[illegible]E 02

TABLE 4.4.2-1 (Cont'd)

$\bar{M}_T$ = 0.1000E 03 $\bar{N}_T$ = 0.2940E 01

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.1450E 01	0.3557E 02	0.3557E 02	0.9876E 02	0.9876E 02
0.1000E-00	0.1448E 01	0.3557E 02	0.3557E 02	0.9861E 02	0.9867E 02
0.2000E-00	0.1442E 01	[illegible]	0.3556E 02	0.9813E 02	0.9840E 02
0.3000E-00	0.1428E 01	0.3556E 02	0.3552E 02	0.9719E 02	0.9769E 02
0.4000E-00	0.1404E 01	0.3554E 02	0.3546E 02	0.9551E 02	0.9700E 02
0.5000E-00	0.1363E 01	0.3551E 02	[illegible]	0.9259E 02	0.9551E 02
0.6000E-00	0.1293E 01	0.3544E 02	[illegible]	0.8753E 02	0.9304E 02
0.7000E-00	0.1172E 01	0.3530E 02	0.3341E 02	0.7880E 02	0.8891E 02
0.8000E-00	0.9661E 00	0.3497E 02	0.3106E 02	0.6374E 02	0.8202E 02
0.9000E-00	0.6110E 00	0.3420E 02	0.2376E 02	0.3795E 02	0.7052E 02
1.0000E-00	0.	0.3235E 02	0.7190E 01	0.1496E-02	0.5319E 02

$\bar{M}_T$ = 0.1000E 03 $\bar{N}_T$ = 0.5000E 01

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.1495E 01	0.3462E 02	0.3462E 02	0.9867E 02	0.9867E 02
0.1000E-00	0.1493E 01	0.3462E 02	0.3461E 02	0.9851E 02	0.9858E 02
0.2000E-00	0.1485E 01	0.3461E 02	0.3460E 02	0.9801E 02	[illegible]
0.3000E-00	0.1471E 01	0.3460E 02	0.3456E 02	0.9703E 02	0.9776E 02
0.4000E-00	0.1446E 01	0.3458E 02	0.3446E 02	0.9528E 02	0.9683E 02
0.5000E-00	0.1402E 01	0.3455E 02	0.3429E 02	[illegible]	0.9529E 02
0.6000E-00	0.1328E 01	0.3447E 02	0.3382E 02	0.8707E 02	0.9274E 02
0.7000E-00	0.1202E 01	0.3431E 02	0.3267E 02	0.7819E 02	0.8854E 02
0.8000E-00	0.9886E 00	0.3395E 02	0.2771E 02	0.6303E 02	0.8157E 02
0.9000E-00	0.6232E 00	0.3312E 02	0.2198E 02	0.3735E 02	0.7007E 02
1.0000E-00	0.	0.3116E 02	0.4734E 01	0.2555E-03	0.5293E 02

$\bar{M}_T$ = 0.1000E 03 $\bar{N}_T$ = 0.1000E 02

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.1604E 01	0.3253E 02	0.3253E 02	0.9842E 02	[illegible]
0.1000E-00	0.1602E 01	0.3253E 02	0.3253E 02	0.9824E 02	0.9831E 02
0.2000E-00	0.1593E 01	0.3253E 02	0.3251E 02	0.9769E 02	0.9800E 02
0.3000E-00	0.1576E 01	0.3251E 02	0.3246E 02	0.9660E 02	0.9740E 02
0.4000E-00	0.1547E 01	0.3249E 02	0.3235E 02	0.9469E 02	0.9639E 02
0.5000E-00	0.1497E 01	0.3244E 02	0.3209E 02	0.9145E 02	0.9473E 02
0.6000E-00	0.1414E 01	0.3234E 02	0.3151E 02	0.8597E 02	0.9202E 02
0.7000E-00	0.1275E 01	0.3213E 02	0.3009E 02	0.7678E 02	0.8763E 02
0.8000E-00	0.1042E 01	0.3170E 02	0.2660E 02	0.6141E 02	0.8222E 02
0.9000E-00	0.6523E 00	0.3072E 02	0.1784E 02	0.3598E 02	0.6901E 02
1.0000E-00	0.	0.2851E 02	-0.1004E 01	0.5435E-04	0.5229E 02

4.4.2 (Cont'd)

TABLE 4.4.2-1 (Cont'd)

$\overline{M}_T$ = 0.1000E 03 $\qquad$ $\overline{N}_T$ = 0.2500E 02

$\overline{r}$	$\overline{w}$	$\overline{N}_r$	$\overline{N}_t$	$\overline{M}_r$	$\overline{M}_t$
0.	0.1934E 01	0.2797E 02	0.2797E 02	0.9756E 02	0.9756E 02
0.1000E-00	0.1930E 01	0.2796E 02	0.2795E 02	0.9733E 02	0.9743E 02
0.2000E-00	0.1917E 01	0.2795E 02	0.2790E 02	0.9661E 02	0.9702E 02
0.3000E-00	0.1892E 01	0.2792E 02	0.2779E 02	0.9524E 02	0.9626E 02
0.4000E-00	0.1850E 01	0.2786E 02	0.2756E 02	0.9289E 02	0.9500E 02
0.5000E-00	0.1780E 01	0.2776E 02	0.2708E 02	0.8902E 02	0.9299E 02
0.6000E-00	0.1669E 01	0.2757E 02	0.2601E 02	0.8277E 02	0.8985E 02
0.7000E-00	0.1489E 01	0.2720E 02	0.2366E 02	0.7273E 02	0.8496E 02
0.8000E-00	0.1200E 01	0.2648E 02	0.1831E 02	0.5680E 02	0.7741E 02
0.9000E-00	0.7377E 00	0.2499E 02	0.6061E 01	0.3213E 02	0.6595E 02
1.0000E-00	0.	0.2189E 02	-0.1798E 02	-0.2956E-04	0.5045E 02

$\overline{M}_T$ = 0.1000E 03 $\qquad$ $\overline{N}_T$ = 0.1000E 03

$\overline{r}$	$\overline{w}$	$\overline{N}_r$	$\overline{N}_t$	$\overline{M}_r$	$\overline{M}_t$
0.	0.3313E 01	0.2268E 02	0.2268E 02	0.9410E 02	0.94[illegible]E 02
0.1000E-00	0.3303E 01	0.2266E 02	0.2260E 02	0.9365E 02	0.9384E 02
0.2000E-00	0.3272E 01	0.2257E 02	0.2232E 02	0.9227E 02	0.9305E 02
0.3000E-00	0.3214E 01	0.2240E 02	0.2174E 02	0.8971E 02	0.9163E 02
0.4000E-00	0.3119E 01	0.2211E 02	0.2059E 02	0.8552E 02	0.8934E 02
0.5000E-00	0.2970E 01	0.2161E 02	0.1856E 02	0.7903E 02	0.8590E 02
0.6000E-00	0.2741E 01	0.2075E 02	0.1395E 02	0.6932E 02	0.8086E 02
0.7000E-00	0.2393E 01	0.1923E 02	0.5233E 01	0.5536E 02	0.7374E 02
0.8000E-00	0.1871E 01	0.1653E 02	-0.1201E 02	0.3661E 02	0.6418E 02
0.9000E-00	0.1101E 01	0.1172E 02	-0.4537E 02	0.1500E 02	0.5270E 02
1.0000E-00	0.	0.3266E 01	-0.9855E 02	-0.3814E-04	0.4256E 02

$\overline{M}_T$ = 0.1000E 04 $\qquad$ $\overline{N}_T$ = 0.

$\overline{r}$	$\overline{w}$	$\overline{N}_r$	$\overline{N}_t$	$\overline{M}_r$	$\overline{M}_t$
0.	0.2345E 01	0.2246E 03	0.2243E 03	1.0000E 03	1.0000E 03
0.1000E-00	[illegible]	0.2246E 03	0.2246E 03	1.0000E 03	1.0000E 03
0.2000E-00	[illegible]	[illegible]	0.2246E 03	[illegible]	[illegible]
0.3000E-00	[illegible]	[illegible]	0.2240E 03	[illegible]	[illegible]
0.4000E-00	0.2345E 01	0.2246E 03	0.2245E 03	[illegible]	[illegible]
0.5000E-00	0.2343E 01	0.2246E 03	0.2245E 03	[illegible]	[illegible]
0.6000E-00	0.2337E 01	0.2245E 03	0.2245E 03	[illegible]	[illegible]
0.7000E-00	0.2313E 01	0.2245E 03	0.2244E 03	[illegible]	[illegible]
0.8000E-00	0.2212E 01	0.2245E 03	0.2235E 03	[illegible]	0.9752E 03
0.9000E-00	0.1766E 01	[illegible]	0.2107E 03	[illegible]	0.8960E 03
1.0000E-00	0.	0.2170E 03	0.6505E 02	0.5314E 00	0.6989E 03

TABLE 4.4.2-1 (Cont'd)

$\bar{M}_T$ = 0.1000E 04 $\bar{N}_T$ = 0.2940E 01

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.2362E 01	0.2229E 03	0.2229E 03	1.0000E 03	1.0000E 03
0.1000E-00	0.2362E 01	0.2229E 03	0.2229E 03	0.9999E 03	1.0000E 03
0.2000E-00	0.2362E 01	0.2229E 03	0.2229E 03	0.9999E 03	0.9999E 03
0.3000E-00	0.2361E 01	0.2229E 03	0.2229E 03	0.9999E 03	0.9999E 03
0.4000E-00	0.2361E 01	0.2229E 03	0.2229E 03	0.9997E 03	0.9998E 03
0.5000E-00	0.2360E 01	0.2229E 03	0.2229E 03	0.9990E 03	0.9996E 03
0.6000E-00	0.2354E 01	0.2229E 03	0.2229E 03	0.9961E 03	0.9984E 03
0.7000E-00	0.2329E 01	0.2229E 03	0.2228E 03	0.9840E 03	0.9939E 03
0.8000E-00	0.2226E 01	0.2228E 03	0.2220E 03	[illegible]	0.9749E 03
0.9000E-00	0.1797E 01	0.2223E 03	0.2090E 03	0.7215E 03	0.8975E 03
1.0000E-00	0.	0.2153E 03	0.6208E 02	0.1335E-01	0.6285E 03

$\bar{M}_T$ = 0.1000E 04 $\bar{N}_T$ = 0.5000E 01

0.	0.2373E 01	0.2217E 03	0.2217E 03	1.0000E 03	1.0000E 03
0.1000E-00	0.2373E 01	0.2217E 03	0.2217E 03	0.9999E 03	1.0000E 03
0.2000E-00	0.2373E 01	0.2217E 03	0.2217E 03	0.9999E 03	0.9999E 03
0.3000E-00	0.2373E 01	0.2217E 03	0.2217E 03	0.9999E 03	0.9999E 03
0.4000E-00	0.2373E 01	0.2217E 03	0.2217E 03	0.9997E 03	0.9998E 03
0.5000E-00	0.2371E 01	0.2217E 03	0.2217E 03	0.9990E 03	0.9996E 03
0.6000E-00	0.2365E 01	0.2217E 03	0.2217E 03	0.9960E 03	0.9984E 03
0.7000E-00	0.2340E 01	0.2217E 03	0.2217E 03	0.9838E 03	0.9937E 03
0.8000E-00	0.2236E 01	0.2217E 03	0.2208E 03	0.9330E 03	0.9747E 03
0.9000E-00	0.1804E 01	0.2212E 03	0.2076E 03	0.7206E 03	0.8971E 03
1.0000E-00	0.	0.2141E 03	0.5981E 02	0.3875E-02	0.6284E 03

$\bar{M}_T$ = 0.1000E 04 $\bar{N}_T$ = 0.1000E 02

0.	0.2401E 01	0.2191E 03	0.2191E 03	1.0000E 03	1.0000E 03
0.1000E-00	0.2401E 01	0.2191E 03	0.2191E 03	0.9999E 03	1.0000E 03
0.2000E-00	0.2401E 01	0.2191E 03	0.2191E 03	0.9999E 03	0.9999E 03
0.3000E-00	0.2401E 01	0.2191E 03	0.2191E 03	0.9999E 03	0.9999E 03
0.4000E-00	0.2401E 01	0.2191E 03	0.2191E 03	0.9997E 03	0.9998E 03
0.5000E-00	0.2399E 01	0.2191E 03	0.2191E 03	0.9990E 03	0.9995E 03
0.6000E-00	0.2393E 01	0.2191E 03	0.2191E 03	0.9959E 03	0.9983E 03
0.7000E-00	0.2367E 01	0.2191E 03	0.2190E 03	0.9834E 03	0.9935E 03
0.8000E-00	0.2260E 01	0.2190E 03	0.2181E 03	0.9318E 03	0.9743E 03
0.9000E-00	0.1820E 01	0.2185E 03	0.2044E 03	0.7182E 03	0.8961E 03
1.0000E-00	0.	0.2112E 03	0.5386E 02	0.1136E-02	0.6280E 03

TABLE 4.4.2-1 (Cont'd)

$\bar{M}_T$ = 0.1000E 04 $\bar{N}_T$ = 0.2500E 02

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.2486E 01	0.2114E 03	0.2114E 03	1.0000E 03	1.0000E 03
0.1000E-00	0.2486E 01	0.2114E 03	0.2114E 03	0.9999E 03	0.9999E 03
0.2000E-00	0.2486E 01	0.2114E 03	0.2114E 03	0.9999E 03	0.9999E 03
0.3000E-00	0.2486E 01	0.2114E 03	0.2114E 03	0.9999E 03	0.9999E 03
0.4000E-00	0.2486E 01	0.2114E 03	0.2114E 03	0.9997E 03	0.9998E 03
0.5000E-00	0.2486E 01	0.2114E 03	0.2114E 03	0.9988E 03	0.9995E 03
0.6000E-00	0.2477E 01	0.2114E 03	0.2113E 03	0.9955E 03	0.9981E 03
0.7000E-00	0.2448E 01	0.2113E 03	0.2113E 03	0.9821E 03	0.9930E 03
0.8000E-00	0.2352E 01	0.2113E 03	0.2102E 03	0.9283E 03	0.9728E 03
0.9000E-00	0.1869E 01	0.2107E 03	0.1952E 03	0.7113E 03	0.8932E 03
1.0000E-00	0.	0.2079E 03	0.3657E 02	0.7247E-03	0.6268E 03

$\bar{M}_T$ = 0.1000E 04 $\bar{N}_T$ = 0.1000E 03

0.	0.2925E 01	0.1794E 03	0.1794E 03	[illegible]	[illegible]
0.1000E-00	0.2925E 01	0.1794E 03	0.1794E 03	[illegible]	[illegible]
0.2000E-00	0.2925E 01	0.1794E 03	0.1794E 03	[illegible]	[illegible]
0.3000E-00	0.2925E 01	0.1794E 03	0.1794E 03	[illegible]	[illegible]
0.4000E-00	0.2924E 01	0.1794E 03	0.1794E 03	[illegible]	[illegible]
0.5000E-00	0.2920E 01	0.1794E 03	0.1794E 03	[illegible]	[illegible]
0.6000E-00	0.2907E 01	0.1794E 03	0.1794E 03	[illegible]	[illegible]
0.7000E-00	[illegible]	0.1794E 03	0.1792E 03	[illegible]	[illegible]
0.8000E-00	[illegible]	0.1793E 03	0.1772E 03	[illegible]	[illegible]
0.9000E-00	0.2111E 01	0.1783E 03	0.1536E 03	[illegible]	[illegible]
1.0000E-00	0.	[illegible]	[illegible]	[illegible]	[illegible]

$\bar{M}_T$ = 0.2000E 04 $\bar{N}_T$ = 0.

0.	[illegible]	0.3874E 03	0.3874E 03	[illegible]	[illegible]
0.1000E-00	[illegible]	0.3874E 03	0.3874E 03	[illegible]	[illegible]
0.2000E-00	[illegible]	0.3874E 03	[illegible]	[illegible]	[illegible]
0.3000E-00	[illegible]	[illegible]	0.3873E 03	[illegible]	[illegible]
0.4000E-00	[illegible]	0.3874E 03	0.3873E 03	[illegible]	[illegible]
0.5000E-00	[illegible]	0.3873E 03	0.3873E 03	[illegible]	[illegible]
0.6000E-00	[illegible]	0.3873E 03	0.3873E 03	[illegible]	[illegible]
0.7000E-00	[illegible]	0.3873E 03	0.3872E 03	[illegible]	[illegible]
0.8000E-00	0.2768E 01	0.3873E 03	[illegible]	[illegible]	[illegible]
0.9000E-00	[illegible]	0.3870E 03	[illegible]	[illegible]	[illegible]
1.0000E-00	0.	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 4.4.2-1 (Cont'd)

$\bar{M}_T$ = 0.2000E 04 $\qquad$ $\bar{N}_T$ = 0.2940E 01

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.2842E 01	0.3856E 03	0.3856E 03	0.2000E 04	0.2000E 04
0.1000E-00	0.2842E 01	0.3856E 03	0.3856E 03	0.2000E 04	0.2000E 04
0.2000E-00	0.2842E 01	0.3856E 03	0.3856E 03	0.2000E 04	0.2000E 04
0.3000E-00	0.2842E 01	0.3856E 03	0.3856E 03	0.2000E 04	0.2000E 04
0.4000E-00	0.2842E 01	0.3856E 03	0.3856E 03	0.2000E 04	0.2000E 04
0.5000E-00	0.2842E 01	0.3856E 03	0.3856E 03	0.1999E 04	0.1999E 04
0.6000E-00	0.2841E 01	0.3856E 03	0.3856E 03	0.1998E 04	0.1999E 04
0.7000E-00	0.2832E 01	0.3856E 03	0.3856E 03	0.1991E 04	0.1996E 04
0.8000E-00	0.2778E 01	0.3856E 03	0.3854E 03	0.1944E 04	0.1980E 04
0.9000E-00	0.2416E 01	0.3853E 03	0.3750E 03	0.1631E 04	0.1870E 04
1.0000E-00	0.	0.3751E 03	0.1101E 03	0.5632E-01	0.1286E 04

$\bar{M}_T$ = 0.2000E 04 $\qquad$ $\bar{N}_T$ = 0.5000E 01

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.2850E 01	0.3845E 03	0.3845E 03	0.2000E 04	0.2000E 04
0.1000E-00	0.2850E 01	0.3845E 03	0.3845E 03	0.2000E 04	0.2000E 04
0.2000E-00	0.2850E 01	0.3845E 03	0.3845E 03	0.2000E 04	0.2000E 04
0.3000E-00	0.2850E 01	0.3845E 03	0.3845E 03	0.2000E 04	0.2000E 04
0.4000E-00	0.2850E 01	0.3845E 03	0.3845E 03	0.2000E 04	0.2000E 04
0.5000E-00	0.2850E 01	0.3845E 03	0.3845E 03	0.1999E 04	0.1999E 04
0.6000E-00	0.2849E 01	0.3845E 03	0.3845E 03	0.1998E 04	0.1999E 04
0.7000E-00	0.2840E 01	0.3845E 03	0.3845E 03	0.1991E 04	0.1996E 04
0.8000E-00	0.2785E 01	0.3845E 03	0.3842E 03	0.1944E 04	0.1980E 04
0.9000E-00	0.2471E 01	0.3842E 03	0.3738E 03	0.1630E 04	0.1870E 04
1.0000E-00	0.	0.3739E 03	0.1078E 03	0.1512E-01	0.1286E 04

$\bar{M}_T$ = 0.2000E 04 $\qquad$ $\bar{N}_T$ = 0.1000E 02

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.2869E 01	0.3817E 03	0.3817E 03	0.2000E 04	0.2000E 04
0.1000E-00	0.2869E 01	0.3817E 03	0.3817E 03	0.2000E 04	0.2000E 04
0.2000E-00	0.2869E 01	0.3817E 03	0.3817E 03	0.2000E 04	0.2000E 04
0.3000E-00	0.2869E 01	0.3817E 03	0.3817E 03	0.2000E 04	0.2000E 04
0.4000E-00	0.2869E 01	0.3817E 03	0.3817E 03	0.2000E 04	0.2000E 04
0.5000E-00	0.2869E 01	0.3817E 03	0.3817E 03	0.1999E 04	0.1999E 04
0.6000E-00	0.2867E 01	0.3817E 03	0.3817E 03	0.1998E 04	0.1999E 04
0.7000E-00	0.2859E 01	0.3817E 03	0.3817E 03	0.1991E 04	0.1996E 04
0.8000E-00	0.2803E 01	0.3817E 03	0.3814E 03	0.1943E 04	0.1979E 04
0.9000E-00	0.2434E 01	0.3814E 03	0.3708E 03	0.1627E 04	0.1869E 04
1.0000E-00	0.	0.3710E 03	0.1025E 03	0.3662E-02	0.1286E 04

TABLE 4.4.2-1 (Cont'd)

$\bar{M}_T = 0.2000E\ 04$ $\qquad$ $\bar{N}_T = 0.2500E\ 02$

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.2926E 01	0.3738E 03	0.3738E 03	0.2000E 04	0.2000E 04
0.1000E-00	0.2926E 01	0.3738E 03	0.3738E 03	0.2000E 04	0.2000E 04
0.2000E-00	0.2926E 01	0.3738E 03	0.3738E 03	0.2000E 04	0.2000E 04
0.3000E-00	0.2926E 01	0.3738E 03	0.3738E 03	0.2000E 04	0.2000E 04
0.4000E-00	0.2926E 01	0.3738E 03	0.3738E 03	0.2000E 04	0.2000E 04
0.5000E-00	0.2925E 01	0.3738E 03	0.3738E 03	0.1999E 04	0.1999E 04
0.6000E-00	0.2924E 01	0.3738E 03	0.3738E 03	0.1998E 04	0.1999E 04
0.7000E-00	0.2915E 01	0.3738E 03	0.3738E 03	0.1990E 04	0.1996E 04
0.8000E-00	0.2855E 01	0.3738E 03	0.3734E 03	0.1941E 04	0.1979E 04
0.9000E-00	0.2473E 01	0.3734E 03	0.3620E 03	0.1620E 04	0.1866E 04
1.0000E-00	0.	0.3626E 03	0.8473E 02	0.5188E-03	0.1285E 04

$\bar{M}_T = 0.2000E\ 04$ $\qquad$ $\bar{N}_T = 0.1000E\ 03$

$\bar{r}$	$\bar{w}$	$\bar{N}_r$	$\bar{N}_t$	$\bar{M}_r$	$\bar{M}_t$
0.	0.3215E 01	0.3378E 03	0.3378E 03	0.2000E 04	0.2000E 04
0.1000E-00	0.3215E 01	0.3378E 03	0.3378E 03	0.2000E 04	0.2000E 04
0.2000E-00	0.3215E 01	0.3378E 03	0.3378E 03	0.2000E 04	0.2000E 04
0.3000E-00	0.3215E 01	0.3378E 03	0.3378E 03	0.2000E 04	0.2000E 04
0.4000E-00	0.3215E 01	0.3378E 03	0.3378E 03	0.1999E 04	0.2000E 04
0.5000E-00	0.3215E 01	0.3378E 03	0.3378E 03	0.1999E 04	0.1999E 04
0.6000E-00	0.3213E 01	0.3378E 03	0.3378E 03	0.1997E 04	0.1999E 04
0.7000E-00	0.3199E 01	0.3378E 03	0.3378E 03	0.1988E 04	0.1995E 04
0.8000E-00	0.3122E 01	0.3378E 03	0.3373E 03	0.1929E 04	0.1974E 04
0.9000E-00	0.2669E 01	0.3373E 03	0.3216E 03	0.1587E 04	0.1853E 04
1.0000E-00	0.	0.3242E 03	-0.9233E 00	0.2807E-02	0.1280E 04

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SECTION 5

AXISYMMETRIC STRESSES AND DEFLECTIONS IN SHELLS DUE TO THERMAL AND MECHANICAL LOADS

by

M. Newman

M. Forray

SECTION 5

AXISYMMETRIC STRESSES AND DEFLECTIONS IN SHELLS DUE TO THERMAL AND MECHANICAL LOADS

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SECTION 5 - AXISYMMETRIC STRESSES AND DEFLECTIONS IN SHELLS DUE TO THERMAL AND MECHANICAL LOADS

5.1 SUMMARY

This section considers the axisymmetric stresses and deflections in heated shells under load. Basic equations, applicable to general shells of revolution, are derived in Sub-section 5.3. These are discussed and applied specifically to conical shells (Sub-section 5.4) and cylindrical shells (Sub-section 5.5) where solutions to the differential equations are given.

5.2. INTRODUCTION

The purpose of this section is to present the theory for the linear elastic analysis of shells of revolution subjected to axisymmetric mechanical loads and temperatures. The formulation used is the linearized version of the development given by E. Reissner (Reference 5-1), extended to include the effects of temperature.

The present work is exact within the framework of linear shell theory and removes the following restrictions of the more elementary presentation in Section 7, Volume I (Reference 5-2):

(1) The material in Volume I was limited to the cases of truncated conical and cylindrical shells.

(2) The development in that volume was approximate for the conical shells and,

(3) The temperature was constant through the thickness, i.e., only meridional variation was permitted.

Since the main objective of this section is to develop the general equations governing the analysis of axisymmetric shells, minimal emphasis is placed upon obtaining specific numerical results. However, problems involving interaction between shells and bulkheads are discussed and, for the purposes of illustration, the general solution for conical and cylindrical shells are derived. Numerical results are given for an unrestrained cylindrical shell subjected to a prescribed temperature variation.

The following symbols are used throughout this section:

h	Shell thickness
ℓ	$\frac{\sqrt{Rh}}{\sqrt[4]{3(1-\nu^2)}}$
r	Distance from a general point on the meridian to the axis of revolution
s	Meridional coordinate

u	Displacement in the r direction
w	Axial displacement
z	Axial coordinate
D	Flexural rigidity, $\frac{Eh^3}{12(1-\nu^2)}$
E	Young's modulus
$G(s)$, $H(s)$	Load - temperature functions defined by Eqs. (1b) of Paragraph 5.5.2 and (1b) of Paragraph 5.4.2, respectively
H	Horizontal force per unit of circumferential length
K	Curvature
L	Length
M	Moment per unit of length
N	Force per unit of length
M_T, N_T	$\int_h E\lambda T\zeta d\zeta$, $\int_h E\lambda T d\zeta$, respectively
P	Surface traction (force per unit of area)
P_H, P_V	Horizontal and vertical components of P, respectively
Q	Shear force per unit of circumferential length perpendicular to shell mid-plane
R	Radius of cylinder
T	Temperature rise above unstressed undeflected datum
V	Vertical force per unit of circumferential length
α	$\sqrt{(r')^2 + (z')^2}$
β	Rotation of meridional element
ϵ	Strain
ζ	Thickness coordinate
θ	Azimuth or hoop angle
λ	Coefficient of linear thermal expansion
ν	Poisson's ratio
ξ	Meridional coordinate
ρ	$\sqrt[4]{\frac{Eh\tan^2\phi}{D}}$
σ	Stress
ϕ	Angle between tangent to meridian and the horizontal
φ	$2\rho s^{\frac{1}{2}}$

SUBSCRIPTS

o, 1	Refer to shell edges
c, p	Complementary and particular solution, respectively
i, f	Initial and final respectively
s	In the meridional direction
θ	In the azimuth or hoop direction
ξ	In the meridional direction

5.3 BASIC EQUATIONS

5.3.1 Configuration of a Typical Shell Element

Since this study is concerned with axisymmetric problems for a shell of revolution it is sufficient to consider a typical meridional element before and after deformation due to loads and temperature (Figure 5.3.1-1). Positive directions for loads and displacements are as shown in the figure. The equation of the meridional curve is expressed parametrically by

$$r = r(\xi) \qquad z = z(\xi) \tag{1a}$$

where ξ is the independent variable which defines the position of a general point on the meridional mid-surface curve. However, the quantity ξ may not have the units of length (for example, ξ may denote an angle). In order to define length along the curve in a general manner, we introduce the quantity $\alpha = \alpha(\xi)$, such that a differential arc length ds is given by

$$ds = \alpha d\xi . \tag{1b}$$

But,

$$\cos\varphi = \frac{dr}{ds} = \frac{dr}{\alpha d\xi} = \frac{r'}{\alpha} \qquad \sin\varphi = \frac{dz}{ds} = \frac{dz}{\alpha d\xi} = \frac{z'}{\alpha} . \tag{1c}$$

Therefore,

$$(r')^2 + (z')^2 = \alpha^2 , \tag{1d}$$

which defines α.

We consider that the tangent to the meridional curve before deformation makes an angle φ with a radial line normal to the axis of revolution; the angle after deformation is designated by $(\varphi + \beta)$. Other quantities in the figure are self-explanatory or indicated in the nomenclature, and moment vectors are obtained using the right-hand rule.

5.3.2 Equilibrium Equations

In the following derivation the forces per unit of circumferential length are designated by the components (N_ξ, Q) or the statically equivalent components (V, H). The relationships between these two sets of forces are given by

$$Q = V\cos\varphi - H\sin\varphi \qquad N_\xi = V\sin\varphi + H\cos\varphi \tag{1}$$

where, in the linear theory, the initial configuration is employed in writing the force equilibrium equations (terms in β neglected).

A free body diagram showing equilibrium of forces (Figure 5.3.2-1) yields the following equations:

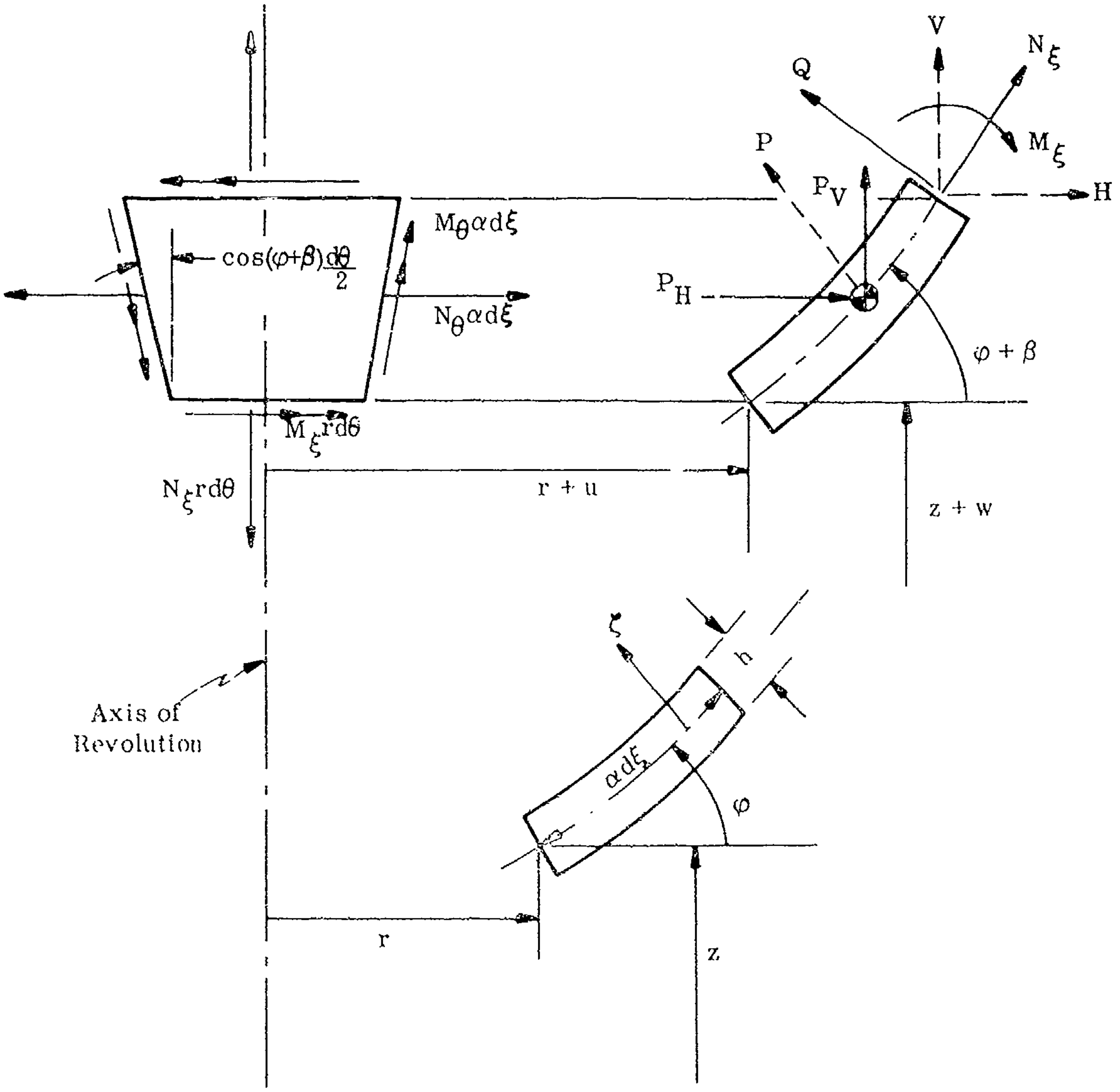

FIGURE 5.3.1-1 CONFIGURATION OF A TYPICAL MERIDIONAL ELEMENT BEFORE AND AFTER DEFORMATION

5.3.2 (Cont'd)

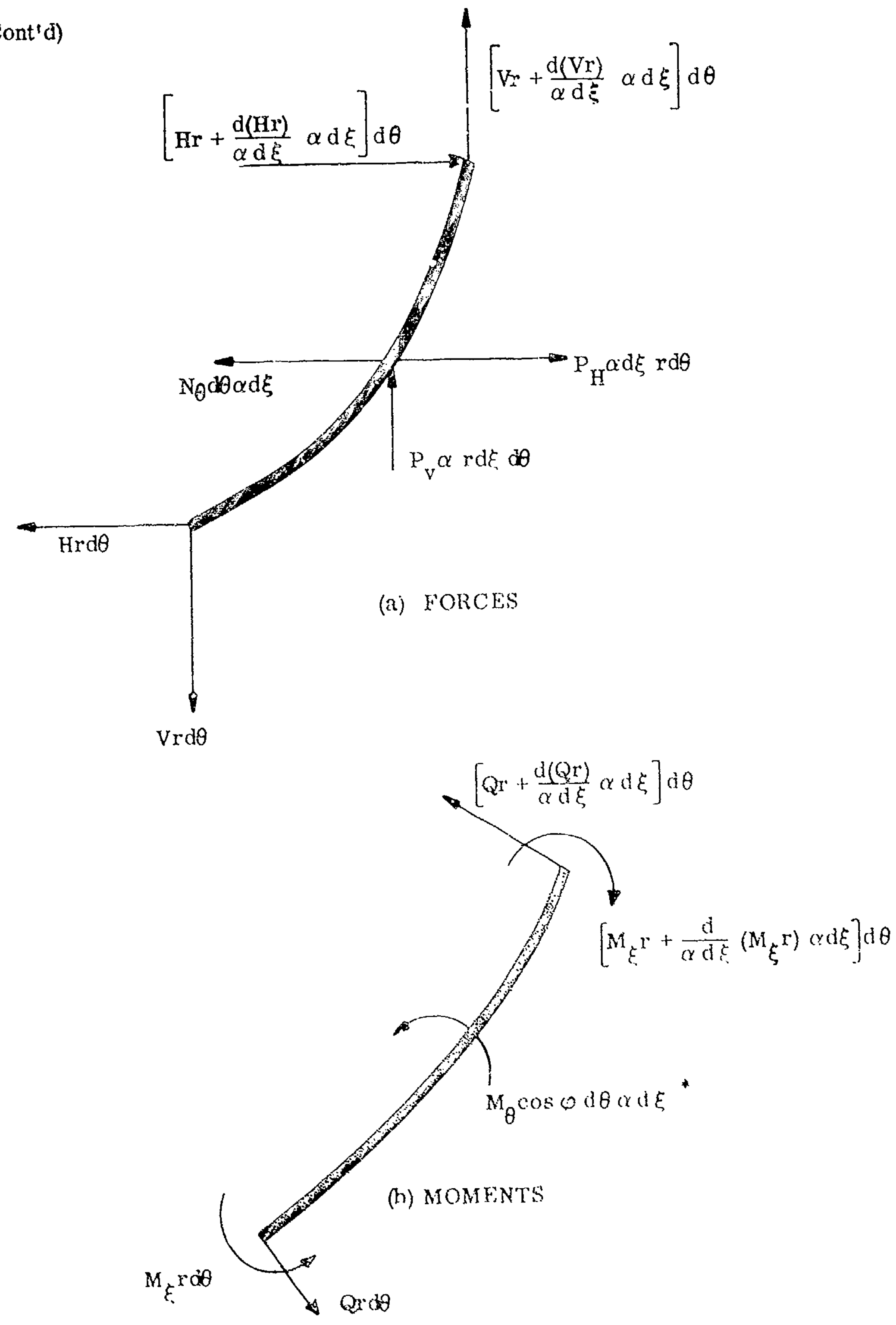

FIGURE 5.3.2-1 EQUILIBRIUM OF FORCES AND MOMENTS

---

* This represents the vector sum of the hoop moments shown in Figure 5.3.1-1. Since the vectors representing the hoop moments form an angle $\cos\varphi d\theta$ (neglecting terms in β), their resultant is of magnitude $M_\theta \cos\varphi d\theta \alpha d\xi$ with the direction as indicated in this figure.

5.3.2 (Cont'd)

$$(rV)' + r\alpha P_V = 0 \tag{2a}$$

$$(rH)' - \alpha N_\theta + r\alpha P_H = 0 \ . \tag{2b}$$

From the free body diagram of Figure 5.3.2-1b, moment equilibrium results in

$$(rM_\xi)' - \alpha \cos\varphi\, M_\theta - \alpha r Q = 0 \ . \tag{3}$$

5.3.3 Curvature Changes and Mid-Surface Strains in Terms of Displacements

Consider a meridional element of the shell mid-surface before deformation (Figure 5.3.1-1). The length of this element is given by

$$dL_i = \frac{\frac{dr}{d\xi}\, d\xi}{\cos\varphi} = \frac{r'd\xi}{\cos\varphi} \ .$$

After deformation, the new length is

$$dL_f = \frac{(r' + u')\, d\xi}{\cos(\varphi + \beta)}$$

where β is the rotation of the element. Thus, the meridional strain of the mid-surface is

$$\epsilon_\xi = \frac{dL_f - dL_i}{dL_i} = \frac{\frac{r' + u'}{\cos(\varphi+\beta)} - \frac{r'}{\cos\varphi}}{\frac{r'}{\cos\varphi}}$$

$$= \left(1 + \frac{u'}{r'}\right) \frac{\cos\varphi}{\cos(\varphi+\beta)} - 1$$

$$= \left(1 + \frac{u'}{r'}\right) \cos\varphi \left[\frac{1}{\cos\varphi} + \frac{\beta \sin\varphi}{\cos^2\varphi} + - - - \right] - 1 \ .$$

If we neglect terms higher than order β, the linear meridional midsurface strain becomes*

$$\epsilon_\xi = \frac{u'}{r'} + \frac{\sin\varphi}{\cos\varphi}\, \beta$$

or

$$\epsilon_\xi = \frac{u'}{r'} + \frac{z'}{r'}\, \beta \ . \tag{1}$$

---

* It should be noted that the derivations in this section involve division by quantities r and r'. Subsequent derivations also involve division by z'. Therefore, at points where these quantities become zero, the resulting derivations and equations become valid only when appropriate limiting processes and regularity conditions are imposed (see Paragraphs 5.4 and 5.5).

5.3.3 (Cont'd)

The hoop strain of the mid-surface ϵ_θ is a measure of the increase in circumferential length per unit of length and is therefore given by

$$\epsilon_\theta = \frac{u}{r}. \tag{2}$$

In order to obtain bending moments in terms of deformations, it is necessary to determine the changes in principal curvatures of the shell mid-surface. From the definition of curvature, the change in meridional curvature due to deformation is

$$K_\xi = \frac{d(\varphi + \beta)}{\alpha d\xi} - \frac{d\varphi}{\alpha d\xi} = \frac{\beta'}{\alpha} \tag{3a}$$

The hoop principal radius of curvature is defined by the length of the normal line to the surface which is bounded by the surface and the axis of revolution. Thus, the change in hoop curvature due to deformation is

$$K_\theta = \frac{\sin(\varphi + \beta) - \sin\varphi}{r}$$

Again, neglecting terms of order higher than β yields

$$K_\theta = \frac{\beta \cos\varphi}{r} \tag{3b}$$

5.3.4 Stress-Strain and Moment-Curvature Relations

The stress-strain relations for the shell mid-surface including temperature are given by

$$\begin{aligned} \sigma_\xi &= \frac{E}{1-\nu^2}(\epsilon_\xi + \nu\epsilon_\theta) - \frac{E\lambda T}{1-\nu} \\ \sigma_\theta &= \frac{E}{1-\nu^2}(\epsilon_\theta + \nu\epsilon_\xi) - \frac{E\lambda T}{1-\nu}, \end{aligned} \tag{1}$$

where λ is the coefficient of linear thermal expansion. Assuming that the strains are linear through the thickness of the shell, the bending strains are odd functions of ζ and therefore integration of the stress-strain relations through the thickness yields

$$\begin{aligned} N_\xi &= \int_h \sigma_\xi \, d\zeta = \frac{Eh}{1-\nu^2}(\epsilon_\xi + \nu\epsilon_\theta) - \frac{N_T}{1-\nu} \\ N_\theta &= \int_h \sigma_\theta \, d\zeta = \frac{Eh}{1-\nu^2}(\epsilon_\theta + \nu\epsilon_\xi) - \frac{N_T}{1-\nu}, \end{aligned} \tag{2}$$

where

$$N_T = \int_h E\lambda T d\zeta .$$

5.3.4 (Cont'd)

For purposes of obtaining expressions for the moments, it is further assumed that normals to the mid-surface before deformation remain normal after deformation, and that mid-surface stretching due to bending is negligible. Then, employing the stress-strain law, integration of the first moments of the stresses through the thickness results in

$$
\begin{aligned}
M_\xi &= \int_h \sigma_\xi \zeta d\zeta = -D\left[K_\xi + \nu K_\theta\right] - \frac{M_T}{1-\nu} \\
M_\theta &= \int_h \sigma_\theta \zeta d\zeta = -D\left[K_\theta + \nu K_\xi\right] - \frac{M_T}{1-\nu}
\end{aligned}
\tag{3}
$$

where

$$D = \frac{Eh^3}{12(1-\nu^2)}$$

$$M_T = \int_h E\lambda T\zeta d\zeta \ .$$

Substitution of Eqs. (1) - (3) of Paragraph 5.3.3 into Eqs. (2) and (3) gives the force resultants and moments in terms of slopes and displacements:

$$
\begin{aligned}
N_\xi &= \frac{Eh}{1-\nu^2}\left[\frac{u' + z'\beta}{r'} + \frac{\nu u}{r}\right] - \frac{N_T}{1-\nu} \\
N_\theta &= \frac{Eh}{1-\nu^2}\left[\frac{u}{r} + \frac{\nu(u' + z'\beta)}{r'}\right] - \frac{N_T}{1-\nu}
\end{aligned}
\tag{4a}
$$

$$
\begin{aligned}
M_\xi &= -D\left[\frac{\beta'}{\alpha} + \frac{\nu\beta r'}{r\alpha}\right] - \frac{M_T}{1-\nu} \\
M_\theta &= -D\left[\frac{\beta r'}{r\alpha} + \frac{\nu\beta'}{\alpha}\right] - \frac{M_T}{1-\nu} ,
\end{aligned}
\tag{4b}
$$

where $\cos\varphi = \frac{r'}{\alpha}$ has been employed.

A compatibility condition in terms of force resultants and slope may now be obtained. Elimination of the displacement u between Eqs. (1) and (2) of Paragraph 3.3 results in

$$\epsilon_\xi = \frac{(r\epsilon_\theta)'}{r'} + \frac{z'}{r'}\beta \ . \tag{5a}$$

The above may be combined with Eqs. (2) to yield

5.3.4 (Cont'd)

$$N_\xi - \nu N_\theta + N_T = \frac{\left[r \left(N_\theta - \nu N_\xi + N_T\right) \right]'}{r'} + \frac{Ehz'\beta}{r'} \tag{5b}$$

5.3.5 Formulation of the Boundary Value Problem

(1) Differential Equation

In the following development, it will be assumed that V is known at one of the shell edges ($V = V_o$ at $\xi = \xi_o$) so that from static equilibrium Eq. (2a) of Paragraph 5.3.2,

$$rV = r_o V_o - \int_{\xi_o}^{\xi} r \, \alpha \, P_V \, d\xi \, . \tag{1}$$

This implies that V is a known quantity throughout the shell.

Then the quantities Q, N_ξ, N_θ, H, M_ξ, M_θ may be eliminated from among the seven equations (1), (2a), (2b), (3) of Paragraph 5.3.2, and (4b) and (5b) of Paragraph 5.3.4, to yield a differential equation for the unknown slope β. After detailed calculation and considerable simplification, this equation may be written in the form:

$$\begin{aligned}
&\left(\frac{r}{r'}\right)^2 \Big[L(\beta) \Big]'' + \frac{1}{\alpha r} \left[\left(\frac{\alpha r}{r'}\right)^2 \left(\frac{r}{\alpha}\right) \right]' \Big[L(\beta) \Big]' + \left[\nu \left\{ \frac{1}{\alpha} \left(\frac{\alpha r}{r'}\right)' \right. \right. \\
&\left. \left. - \nu \right\} - 1 + \frac{1}{r'} \left\{ \frac{r}{\alpha} \left(\frac{\alpha r}{r'}\right)' \right\}' \right] L(\beta) + \frac{Eh}{D} \frac{z'}{r'} \beta = - \frac{r^2}{\alpha z'} \frac{V''}{D} + \left[\nu \frac{r}{r'} \left(\frac{z'}{\alpha}\right) \right. \\
&\left. - \frac{z'}{r r'^2} \left\{ \frac{r^3}{\alpha} \left(\frac{r'}{z'}\right)^2 \right\}' \right] \frac{V'}{D} + \left[- \left(\frac{r}{r'}\right)^2 \left(\frac{r'^2}{\alpha z'}\right)'' - \frac{1}{\alpha r} \left\{ \left(\frac{\alpha r}{r'}\right)^2 \left(\frac{r}{\alpha}\right) \right\}' \left(\frac{r'^2}{\alpha z'}\right)' \right. \\
&\left. - \left\{ \left(\frac{r}{\alpha}\right) \left(\frac{\alpha r}{r'}\right)' \right\}' \frac{r'}{\alpha z'} + \frac{\alpha}{z'} + \nu \left\{ \frac{1}{r'} \left(\frac{rz'}{\alpha}\right)' - \frac{r r'^2}{\alpha^2 z'} \left(\frac{\alpha}{r'}\right)' \right\} \right] \frac{V}{D} \\
&+ \frac{1}{D} \left[-\nu r P_H - \frac{1}{r'} \left(r^2 P_H\right)' - \frac{r}{r'} N_T' \right] - \left(\frac{r}{r'}\right)^2 \left\{ \left(\frac{r'}{z'\alpha}\right) \frac{M_T'}{D(1-\nu)} \right\}'' \\
&- \frac{1}{\alpha r} \left\{ \left(\frac{\alpha r}{r'}\right)^2 \left(\frac{r}{\alpha}\right) \right\}' \left\{ \left(\frac{r'}{z'\alpha}\right) \frac{M_T'}{D(1-\nu)} \right\}' - \left[\nu \left\{ \frac{1}{\alpha} \left(\frac{\alpha r}{r'}\right)' - 1 \right\} - 1 \right. \\
&\left. + \frac{1}{r'} \left\{ \frac{r}{\alpha} \left(\frac{\alpha r}{r'}\right)' \right\}' \right] \left(\frac{r'}{z'\alpha}\right) \frac{M_T'}{D(1-\nu)}
\end{aligned} \tag{2}$$

where

$$L(\beta) = \frac{r'}{z'\alpha^2}\left[\beta'' + \frac{\alpha}{r}\left(\frac{r}{\alpha}\right)'\beta' + \left\{\nu\frac{\alpha}{r}\left(\frac{r'}{\alpha}\right)' - \left(\frac{r'}{r}\right)^2\right\}\beta\right]$$

The Equation (2) is the general differential equation governing the linear analysis for stresses, and deformations in arbitrary shells of revolution due to axisymmetric loads and temperature (see, however, remarks made in footnote, page 5.7).

(2) Force Resultant, Moment, and Displacement Boundary Conditions in Terms of the Slope β.

Since the differential equation (2) is in terms of the dependent variable β, it is advantageous to express the force resultants, moments and displacements, as well as the boundary conditions, as functions of this variable. The derived quantities are given by

$$N_\theta = \frac{D}{\alpha}\left[\frac{r}{\alpha z'}\beta'' + \frac{1}{z'}\left(\frac{r}{\alpha}\right)'\beta' + \left\{\frac{\nu}{z'}\left(\frac{r'}{\alpha}\right)' - \frac{r'^2}{\alpha r z'}\right\}\beta\right]' + \left\{\frac{rr'V}{z'} + \frac{rM_T'}{z'(1-\nu)}\right\}' + rP_H \tag{3a}$$

$$N_\xi = D\left[\frac{r'}{\alpha^2 z'}\beta'' + \frac{r'}{r\alpha z'}\left(\frac{r}{\alpha}\right)'\beta' + \frac{r'}{r\alpha}\left\{\frac{\nu}{z'}\left(\frac{r'}{\alpha}\right)' - \frac{r'^2}{\alpha r z'}\right\}\beta\right] + \frac{\alpha}{z'}V + \frac{r'}{\alpha z'}\frac{M_T'}{1-\nu} \tag{3b}$$

$$Q = -D\left[\frac{1}{\alpha^2}\beta'' + \frac{1}{r\alpha}\left(\frac{r}{\alpha}\right)'\beta' + \left\{\frac{\nu}{r\alpha}\left(\frac{r'}{\alpha}\right)' - \left(\frac{r'}{\alpha r}\right)^2\right\}\beta\right] - \frac{M_T'}{\alpha(1-\nu)} \tag{3c}$$

$$H = \frac{D}{\alpha z'}\left[\beta'' + \frac{\alpha}{r}\left(\frac{r}{\alpha}\right)'\beta' + \left\{\frac{\nu\alpha}{r}\left(\frac{r'}{\alpha}\right)' - \left(\frac{r'}{r}\right)^2\right\}\beta + \frac{\alpha r'V}{D} + \frac{\alpha M_T'}{D(1-\nu)}\right] \tag{3d}$$

$$M_\xi = -D\left[\frac{\beta'}{\alpha} + \frac{\nu r'}{r\alpha}\beta\right] - \frac{M_T}{1-\nu} \tag{3e}$$

$$M_\theta = -D\left[\frac{r'}{r\alpha}\beta + \frac{\nu\beta'}{\alpha}\right] - \frac{M_T}{1-\nu} \tag{3f}$$

$$u = \frac{r}{Eh}\left(N_\theta - \nu N_\xi\right) + \frac{N_T r}{Eh} \tag{3g}$$

$$w = \int_{\xi_o}^{\xi}\left[\frac{z'}{Eh}\left(N_\xi - \nu N_\theta + N_T\right) + r'\beta\right]d\xi . \tag{3h}$$

The stresses may then be obtained from

$$\sigma_\xi = \frac{1}{h}\left(N_\xi + \frac{N_T}{1-\nu}\right) - \frac{E\lambda T}{1-\nu} + \frac{12\zeta}{h^3}\left(M_\xi + \frac{M_T}{1-\nu}\right) \tag{4a}$$

$$\sigma_\theta = \frac{1}{h}\left(N_\theta + \frac{N_T}{1-\nu}\right) - \frac{E\lambda T}{1-\nu} + \frac{12\zeta}{h^3}\left(M_\theta + \frac{M_T}{1-\nu}\right) . \tag{4b}$$

Typical boundary conditions can be expressed in terms of the above derived quantities as shown by the following examples:

(a) Clamped Edge at $\xi = \xi_o$

$$\left[\beta\right]_{\xi=\xi_o} = \left[u\right]_{\xi=\xi_o} = 0 \tag{5a}$$

(b) Pinned Edge at $\xi = \xi_o$

$$\left[u\right]_{\xi=\xi_o} = \left[M_\xi\right]_{\xi=\xi_o} = 0 \tag{5b}$$

(c) Free Edge at $\xi = \xi_o$

$$\left[Q\right]_{\xi=\xi_o} = \left[M_\xi\right]_{\xi=\xi_o} = 0 \tag{5c}$$

(d) Specified Radial Load "H_o" and Meridional Moment "M_o" at edge $\xi = \xi_o$

$$\left[\frac{D}{\alpha z'}\left(\beta'' + \frac{\alpha}{r}\left(\frac{r}{\alpha}\right)'\beta' + \left\{\frac{\nu\alpha}{r}\left(\frac{r'}{\alpha}\right)' - \left(\frac{r'}{r}\right)^2\right\}\beta + \frac{\alpha r' V}{D} + \frac{\alpha M_T'}{D(1-\nu)}\right)\right]_{\xi=\xi_o} = H_o \tag{5d}$$

$$\left[-D\left(\frac{\beta'}{\alpha} + \frac{\nu r'}{r\alpha}\beta\right) - \frac{M_T}{1-\nu}\right]_{\xi=\xi_o} = M_o$$

5.3.5 (Cont'd)

In order to apply the differential equation (2) and boundary conditions (5) to a specific shell geometry, the quantities r, α, z must be determined from the equation of the shell meridian. Specific examples for the cases of conical and cylindrical shells are presented in the following paragraphs. In general, the major problem encountered in solving Eq. (2) for a given shell of revolution involves obtaining the complementary solution for a fourth order differential equation with variable coefficients. Usually closed form solutions are not possible. However, as may be observed from an inspection of the right hand side of Eq. (2), the introduction of temperature does not complicate matters, since it enters in a form analogous to terms resulting from mechanical loads.

The boundary conditions (Eq. (5d)) are of importance in considering the interaction of the shell with both transverse circular bulkheads and other shells of revolution. Once the linear response to edge loads and moments is determined from a solution of Eq. (2) subject to boundary conditions of the type (5d), influence coefficients are known and internal loads at the junctions of shells and bulkheads may be evaluated by imposing compatibility and equilibrium conditions on slopes and deflections. A description of the procedure to be followed is given in detail in Volume I, Section 8.

5.4 CONICAL SHELLS

5.4.1 Basic Equations

A meridional section of the cone and the coordinate system is shown in Figure 5.4.1-1.

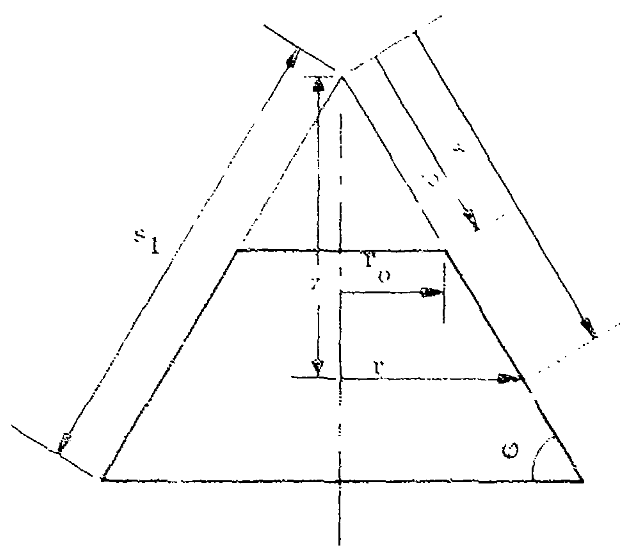

FIGURE 5.4.1-1 CONE GEOMETRY

Referring to Eqs. (1) of Paragraph 5.3.1, we choose the independent variable as

$$\xi = s \tag{13}$$

from which it follows that

$$\left.\begin{aligned} r &= s\cos\varphi \\ z &= s\sin\varphi \\ r' &= \cos\varphi \\ z' &= \sin\varphi \\ \alpha &= 1\,, \end{aligned}\right\} \tag{1b}$$

where φ = constant has been employed and primed quantities indicate differentiation with respect to s.

The above quantities may be substituted into the general differential equation (2) of Paragraph 5.3.5. After simplification, the resulting differential equation for the linear analysis of conical shells becomes

$$\begin{aligned} s\beta^{IV} + 4\beta''' + \rho^4\frac{\beta}{s} = \frac{1}{D}\Big[& \Big(\frac{1}{s}(P_V s^2)' - \nu\tan^2\varphi\, P_V\Big)\cos\varphi \\ & - \frac{1}{\cos\varphi\, s^2}\int_{s_0}^{s} sP_V\,ds - \Big(\frac{1}{s}(P_H s^2)' + \nu P_H\Big)\sin\varphi \\ & + \frac{r_0 V_0}{s^2\cos^2\varphi} - \tan\varphi\, N_T' - \frac{1}{s^2}\Big(\frac{s^3 M_T''}{1-\nu}\Big)'\Big]\,, \end{aligned} \tag{2}$$

where $\rho^4 = \dfrac{Eh\tan^2\varphi}{D}$.

We will consider the special case of normal surface pressure. Then, from Figure 5.3.1-1:

$$P_V = P\cos\varphi$$

$$P_H = P\sin\varphi\,,$$

and Eq. (2) reduces to

$$\begin{aligned} s\beta^{IV} + 4\beta''' + \rho^4\frac{\beta}{s} = \frac{1}{D}\Big[& \frac{1}{s}(Ps^2)' - \frac{1}{s^2}\int_{s_0}^{s} Ps\,ds + \frac{r_0 V_0}{s^2\cos^2\varphi} - \tan\varphi\, N_T' \\ & - \frac{1}{s^2}\Big(s^3\frac{M_T''}{1-\nu}\Big)'\Big]\,. \end{aligned} \tag{3}$$

5.4.1 (Cont'd)

Correspondingly, the expressions for the force resultants and moments are obtained from Eqs. (3) of Paragraph 5.3.5 and are given by

$$N_\theta = \frac{1}{\tan\varphi}\left[D\left(s\beta'' + \beta' - \frac{\beta}{s}\right)' - Ps + \frac{(sM_T')'}{1-\nu} \right] \tag{4a}$$

$$N_s = \frac{1}{\tan\varphi}\left[D\left(\beta'' + \frac{\beta'}{s} - \frac{\beta}{s^2}\right) + \frac{r_0 V_0}{s\cos^2\varphi} - \frac{1}{s}\int_{s_0}^{s} Ps\,ds + \frac{M'_T}{1-\nu} \right] \tag{4b}$$

$$Q = -D\left[\beta'' + \frac{\beta'}{s} - \frac{\beta}{s^2}\right] - \frac{M'_T}{1-\nu} \tag{4c}$$

$$H = \frac{D}{\sin\varphi}\left[\beta'' + \frac{\beta'}{s} - \frac{\beta}{s^2}\right] + \frac{V_0 r_0}{s\sin\varphi} - \frac{\cos^2\varphi}{s\sin\varphi}\int_{s_0}^{s} Ps\,ds + \frac{1}{\sin\varphi}\frac{M'_T}{1-\nu} \tag{4d}$$

$$M_s = -D\left[\beta' + \frac{\nu\beta}{s}\right] - \frac{M_T}{1-\nu} \tag{4e}$$

$$M_\theta = -D\left[\frac{\beta}{s} + \nu\beta'\right] - \frac{M_T}{1-\nu} \tag{4f}$$

5.4.2 Solution of the Differential Equation*

When Eq. (3) of Paragraph 5.4.1 is multiplied by s, we have

$$s^2\beta^{IV} + 4s\beta''' + \alpha^4\beta = H(s) + \frac{r_0 V_0}{Ds\cos^2\varphi} \tag{1a}$$

where

$$H(s) = \frac{1}{D}\left[(Ps^2)' - \frac{1}{s}\int_{s_0}^{s} Ps\,ds - \frac{1}{s}\left(s^3\frac{M''_T}{1-\nu}\right)' - \tan\varphi\, N'_T \right]. \tag{1b}$$

Introduce a new independent variable ξ defined by

$$\xi = 2\alpha s^{\frac{1}{2}} . \tag{2}$$

* This differential equation for cones of revolution subjected to axisymmetric mechanical loads and temperature was solved by [illegible] (Reference 5-3), where reference is given to previous work on the subject. However, the equations did not proceed from any general development on shells of revolution. Furthermore, only linear temperature variations through the thickness are accommodated in this reference.

5.4.2 (Cont'd)

Then the homogeneous form of Eq. (1) becomes

$$\frac{d^4\beta_c}{d\psi^4} + \frac{2}{\psi}\frac{d^3\beta_c}{d\psi^3} - \frac{9}{\psi^2}\frac{d^2\beta_c}{d\psi^2} + \frac{9}{\psi^3}\frac{d\beta_c}{d\psi} + \beta_c = 0 . \tag{3a}$$

This equation is now factorable as

$$\left(\frac{d^2}{d\psi^2} + \frac{1}{\psi}\frac{d}{d\psi} + i - \frac{4}{\psi^2}\right)\left(\frac{d^2}{d\psi^2} + \frac{1}{\psi}\frac{d}{d\psi} - i - \frac{4}{\psi^2}\right)\beta_c = 0 , \tag{3b}$$

for which the solution is

$$\beta_c = c_1 J_2\left(i^{\frac{1}{2}}\psi\right) + c_2 Y_2\left(i^{\frac{1}{2}}\psi\right) + c_3 J_2\left(i^{\frac{3}{2}}\psi\right) + c_4 Y_2\left(i^{\frac{3}{2}}\psi\right), \tag{4}$$

where J_2 and Y_2 are Bessel functions of the first and second kind of order 2. After much manipulation Eq. (4) may be written in terms of Kelvin functions as

$$\beta_c = A\left(\operatorname{ber}\psi - \frac{2}{\psi}\dot{\operatorname{bei}}\psi\right) + B\left(\operatorname{bei}\psi + \frac{2}{\psi}\dot{\operatorname{ber}}\psi\right)$$

$$+ C\left(\ker\psi - \frac{2}{\psi}\dot{\operatorname{kei}}\psi\right) + F\left(\operatorname{kei}\psi + \frac{2}{\psi}\dot{\ker}\psi\right) \tag{5}$$

where $\cdot = \frac{d}{d\psi}$.

The particular solution of Eq. (1) can be easily obtained if the function H(s) is expressed as a polynomial of the form

$$H(s) = \sum_{p=o}^{N} A_p s^p \tag{6}$$

Then, selecting the solution on the form of series involving integral powers of s, there results

$$\beta_p = \frac{r_o V_o}{Ehs \sin^2\varphi} + \frac{A_o}{\rho^4}$$

$$+ \sum_{p=1}^{l} \sum_{m=1}^{p} \left[\frac{(-1)^{p-m}+1}{2}\right] a_m s^m , \tag{7}$$

5.4.2 (Cont'd)

where the a_m are given by

$$a_m = (-1)^{\frac{p-m}{2}} \frac{A_p (p+1)(p)(m+1)(m)}{\rho^2 (p-m+2)} \left[\frac{(p-1)!}{(m+1)!}\right]^2 \quad (8)$$

The total solution to the cone problem is $\beta = \beta_c + \beta_p$ and the constants A, B, C, F must be determined from the four boundary conditions (two at each edge). For the special case of a full cone ($s_o = 0$), finiteness of stresses at the apex requires that $V_o = 0$. Further, regularity conditions on stress resultants and shears, require that "C" = "F" = 0. Specific solutions for the full cone then resolve themselves into the determination of the two constants "A" and "B" from the boundary conditions at the base.

The Kelvin functions and their first derivatives appearing in Eq. (5) are extensively and accurately tabulated in Reference 5-4 for a wide range of the argument. The form of solution developed above is readily adaptable to numerical computation using digital computers. Parametric studies to determine stresses and deflections can be made.

5.5 CYLINDRICAL SHELLS

5.5.1 Basic Equations

The cylinder and the coordinate system is shown in Figure 5.5.1-1.

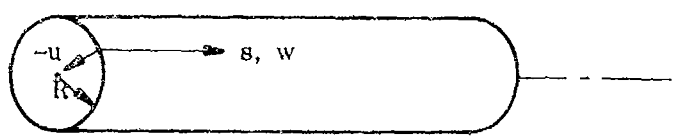

FIGURE 5.5.1-1 CYLINDRICAL GEOMETRY

We choose s again as the independent variable , however, since $r' = 0$ for the cylinder (see Figure 5.3.1-1), then as indicated previously Eq. (2) of Paragraph 5.3.5 is not applicable in the form given. The equations for the cylindrical shell are more readily derivable from the conical shell equations (which were developed from Eq. (2) of Paragraph 5.3.5). Proceeding in this manner, if the equation (3) of Paragraph 5.4.1 is multiplied by $\frac{D}{s}$, the quantity $\frac{1}{s}$ replaced by $\frac{\cos\varphi}{r}$ and the appropriate limit as $\varphi \to \frac{\pi}{2}$, $r \to R$, is taken, there results, for the case of normal pressures,

$$D\beta^{IV} + \frac{Eh\beta}{R^2} = \left[p - \frac{M_T''}{1-\nu} - \frac{N_T}{R} \right]' . \quad (1)$$

Similarly, the limiting process applied to Eqs. (4) of Paragraph 5.4.1 for the force and moment resultants yields

$$
\begin{aligned}
N_\theta &= R\left[D\beta''' + \frac{M_T''}{1-\nu} - P\right] \\
N_s &= V_o \\
Q &= -\left[D\beta'' + \frac{M_T'}{1-\nu}\right] = -H \qquad (2) \\
M_s &= -D\beta' - \frac{M_T}{1-\nu} \\
M_\theta &= -\nu D\beta' - \frac{M_T}{1-\nu} \quad .
\end{aligned}
$$

An alternate form of the equilibrium equation in terms of the radial displacement component "u" can be obtained by integrating Eq. (1) once, noting, that $\beta = -u'$. This results in

$$
Du^{IV} + \frac{Eh}{R^2}u = -P + \frac{M_T''}{1-\nu} + \frac{N_T}{R} - \frac{\nu V_o}{R} \; , \qquad (3)
$$

where the constant of integration is given by the last term on the right. Substituting $\beta = -u'$ into Eqs. (2) the force and moment resultants are

$$
\begin{aligned}
N_\theta &= R\left[-Du^{IV} + \frac{M_T''}{1-\nu} - P\right] \\
N_s &= V_o \\
Q &= Du''' - \frac{M_T'}{1-\nu} = -H \qquad (4) \\
M_s &= Du'' - \frac{M_T}{1-\nu} \\
M_\theta &= \nu Du'' - \frac{M_T}{1-\nu} \; .
\end{aligned}
$$

Using the formulation of Eq. (1), for all sets of boundary conditions involving β, the solution may be integrated once to obtain u. The constant of integration is determined from

the prescribed value of V_o. When using the formulation of Eq. (3), however, V_o appears explicitly in the differential equation.

5.5.2 Solution of the Differential Equation

Equation (3) may be written as

$$\frac{\ell^4}{4} u^{IV} + u = G(s) \tag{1a}$$

where

$$\ell = \frac{\sqrt{Rh}}{\sqrt[4]{3(1-\nu)^2}} \quad (= .778\sqrt{Rh} \text{ for } \nu = .30).$$

and

$$G(s) = \frac{R^2}{Eh}\left[-P + \frac{M_T''}{1-\nu} + \frac{N_T}{R} - \frac{\nu V_o}{R}\right]. \tag{1b}$$

The complementary solution of (1a) is given by

$$u_c = \sinh\frac{s}{\ell}\left(A_1 \sin\frac{s}{\ell} + A_2 \cos\frac{s}{\ell}\right)$$
$$+ \cosh\frac{s}{\ell}\left(A_3 \sin\frac{s}{\ell} + A_4 \cos\frac{s}{\ell}\right). \tag{2}$$

A particular solution can easily be obtained if G(s) is expressed as a polynomial with terms of the form

$$G_k(s) = C_k\left(\frac{s}{R}\right)^k \quad ; \quad k = 0, 1, 2 \ldots M. \tag{3}$$

Then a particular solution corresponding to $G(s) = C_k\left(\frac{s}{R}\right)^k$ can be determined by assuming this solution in the form of a polynomial in $(^s/_R)$ of degree K and substituting in Eq. (1). There results

$$(u_p)_k = \begin{cases} C_k\left(\frac{s}{R}\right)^k & ; \ k \leq 3 \\ \sum\limits_{J=0,1\ldots}^{[N]} A_{(k-4j)}\left(\frac{s}{R}\right)^{(k-4j)} & ; \ k > 3, \end{cases} \tag{4}$$

5.5.2 (Cont'd)

where

$$A_{(k-4j)} = (-1)^j C_k \frac{(k)!}{(k-4j)!} \left[\frac{1}{4} \left(\frac{\ell}{R} \right)^4 \right]^j ,$$

and

$$\left[N \right] = \text{Greatest integer} \leq \frac{k}{4} .$$

The complete solution corresponding to $G(s) = \sum_{k=0}^{M} C_k \left(\frac{s}{R} \right)^k$ is then given by

$$u = u_c + \sum_{k=0}^{M} \left(u_p \right)_k . \tag{5}$$

The constants A_1, A_2, A_3, A_4 must be determined from the specified boundary conditions at the ends of the cylinder. This requires the solution of four simultaneous, linear algebraic equations. In order to eliminate the necessity of solving four equations an approximate method of solution in which the less tedious procedure of solving two pairs of simultaneous equations, each for two unknown constants, is used extensively. The basis of this method is the assumption that edge shears and moments (which are self equilibrating applied at one end of the shell negligibly affect the stresses and deflections at the opposite end. This assumption is valid if the length of the shell "L" satisfies the condition $L > 3\ell$, or equivalently, for $\nu = 0.30$, when $\frac{L}{R} > \frac{7}{3} \left(\frac{h}{R} \right)^{1/2}$. The inequality is satisfied in all but very short/thick cylindrical shells. The method, which appears in Reference 5-2, may be described as follows:

(1) Determine the deflections and stresses corresponding to the particular solution $u_p = \sum_{k=0}^{M} \left(u_p \right)_k$ where the $\left(u_p \right)_k$ are given by Eq. (4) In general this solution will not satisfy the boundary conditions.

(2) Edge moments and loads are then applied to the semi-infinite cylinder such that when their effects are superposed on the solutions of (1) the boundary conditions at each edge are satisfied. Since there are only two conditions to be met at each edge and there is no assumed interaction of edge effects then, for each edge, the solution of two simultaneous equations in two unknowns (one shear and one bending moment) is required.

5.5.3 NUMERICAL EXAMPLE

A free cylindrical shell is subjected to an elevated temperature as shown in Figure 5.5.3-1, i.e., the inside surface of the cylinder is at a uniform elevated temperature T_i and the outside temperature varies linearly from T_i at $s=0$ to a temperature T_i (1+A) at $s=L$. The

5.5.3 (Cont'd)

variation through the thickness of the shell is assumed to be linear. It is required to determine the stresses and deflections.

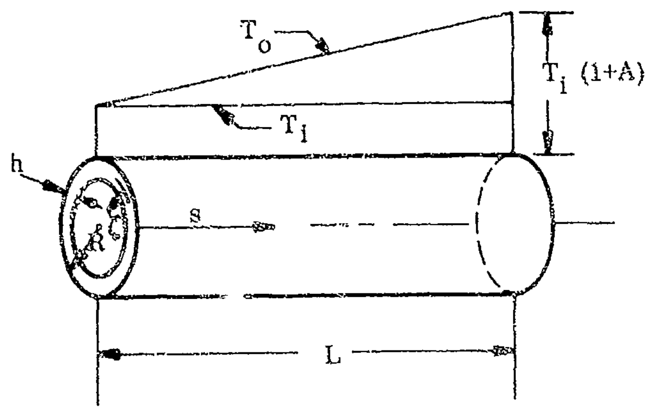

FIGURE 5.5.3-1 ILLUSTRATIVE EXAMPLE

Procedure:

The temperature distribution is given by

$$T(s, \zeta) = T_i \left[1 + \frac{As}{2L} \left(1 - \frac{2\zeta}{h} \right) \right]$$

and therefore

$$N_T = E\lambda \int_{-\frac{h}{2}}^{\frac{h}{2}} T d\zeta = E\lambda T_i \; h \left(1 + \frac{As}{2L} \right)$$

$$M_T = E\lambda \int_{-\frac{h}{2}}^{\frac{h}{2}} T\zeta dz = -E\lambda T_i \; \frac{As}{L} \; \frac{h^2}{12}$$

Referring to Eq. (1b) of Paragraph 5.5.2, since no mechanical loads are applied, $P = V_o = 0$, and Eq.(1a) of Paragraph 5.5.2 becomes $\frac{\ell^4}{4} u^{IV} + u = \frac{R^2}{Eh} \left[\frac{M_T''}{1-\nu} + \frac{N_T}{R} \right]$ $= R\lambda T_i \left(1 + \frac{As}{2L} \right)$.

The right hand side can be written in the form $C_o + C_1 \frac{s}{R}$,

where $$C_o = R\lambda T_i$$

$$C_1 = \frac{R^2 \lambda T_i A}{2L} \quad .$$

Then from Eqs. (2), (4), and (5) of Paragraph 5.5.2 the solution for the displacement is given by

$$u = \sinh\frac{s}{\ell}\left(A_1 \sin\frac{s}{\ell} + A_2 \cos\frac{s}{\ell}\right) + \cosh\frac{s}{\ell}\left(A_3 \sin\frac{s}{\ell} + A_4 \cos\frac{s}{\ell}\right) + R\lambda T_i \left(1 + \frac{A\,s}{2L}\right) . \tag{1}$$

The boundary conditions for free edges are

$$M_s = Q = 0 \quad \text{at } s = o, L,$$

which from Eqs. 4 of Paragraph 5.5.1 can be written as

$$Du'' - \frac{M_T}{1-\nu} = Du''' - \frac{M_T'}{1-\nu} = 0 \quad \text{at} \quad s = o, L. \tag{2}$$

The constants $A_1 - A_4$ in Eq. (1) are determined from the boundary conditions. Force resultants and moments are then found by substituting into Eqs. (2) of Paragraph 5.5.1. Since the calculation details are straightforward, only the results are shown. Figure 5.5.3-2 gives nondimensional deflections, force and moment resultants for both a cylinder with $L/\ell = 10$ and a longer cylinder corresponding to $L/\ell = 50$. The graphs show that as the cylinder becomes longer, the peak deflections and stresses approach the end of the surface subjected to the higher thermal gradient. In general, these peak values tend to increase in magnitude for the longer cylinders, resulting in sharp gradients in the vicinity of the edge.

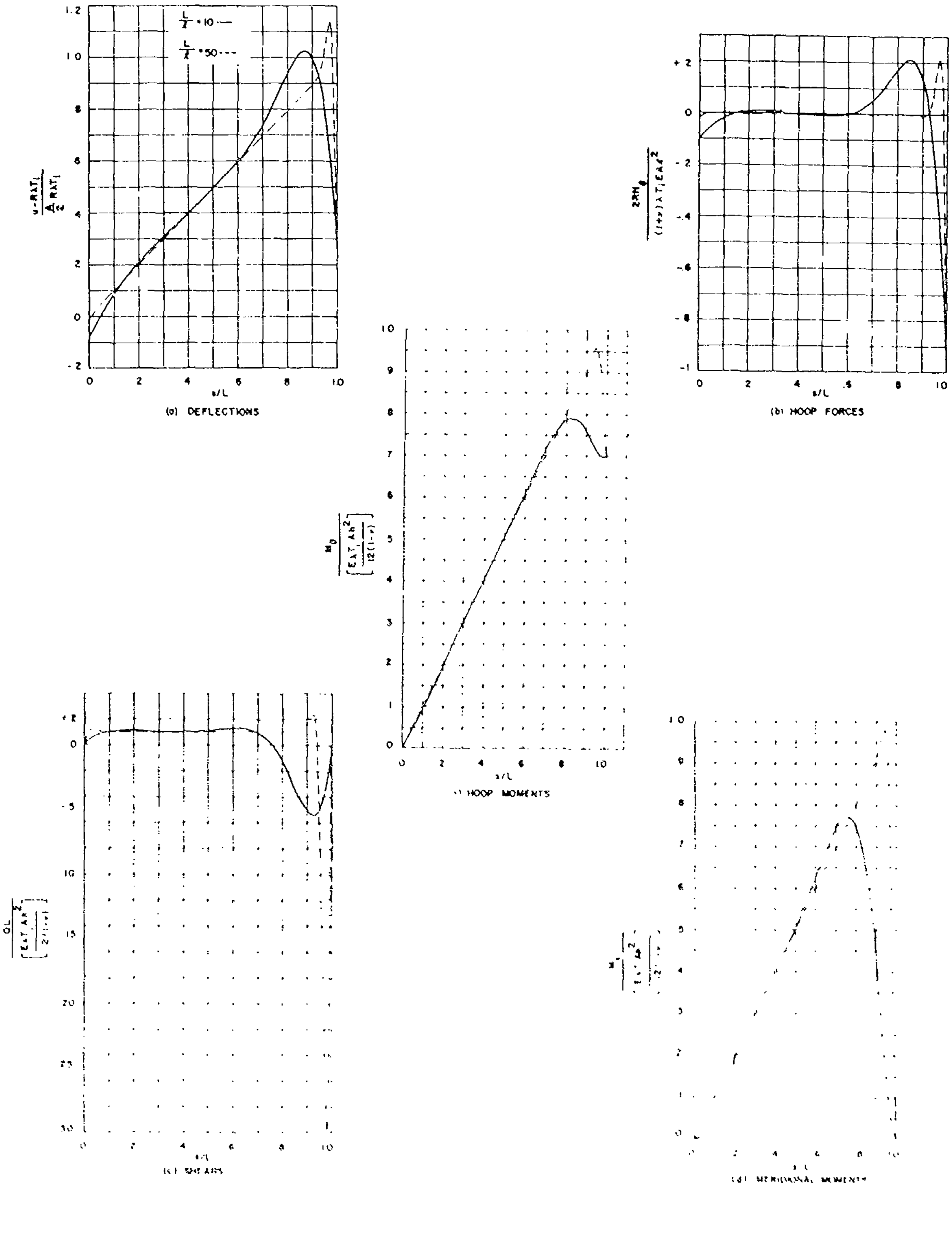

FIGURE 5.5.3-2 NONDIMENSIONAL DEFLECTIONS, FORCE AND MOMENT RESULTANTS FOR THE FREE CYLINDER HEATED AS SHOWN IN FIGURE 5.5.3-1: L/ℓ = 10, 50.

5.6 REFERENCES

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Unclassified Report

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SECTIONS 2 and 3 - ECCENTRIC COLUMNS
Nondimensional curves are presented for the approximate analysis of the buckling and load

(over)

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The general equation for linear thermoelastic analysis of axisymmetric shells is developed. Cylinders and cones are discussed.

1. Thermostructural analysis
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II. Contract AF33(616)-6066
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